BioMaryland 2020: Strategic Framework and Proposed Policy Actions

Prepared for:

The Maryland Life Sciences Advisory Board (LSAB)

Prepared by:

Battelle Technology Partnership Practice

in Collaboration with the LSAB

With funding from

Maryland Technology Development Corporation

May 2009

TABLE OF CONTENTS

WINNING IN TODAY'S GLOBAL KNOWLEDGE ECONOMY REQUIRES FOSTERING LOCAL INNOVATION CLUSTERS … FOR MARYLAND, THE BIOSCIENCES ARE STRATEGICALLY KEY

The nation and the world are going through highly turbulent economic times that expose the interconnected nature of today's global economy. While the day-to-day ups and downs of the global economy garner newspaper headlines, an intense global competition is underway to attract and develop the innovative, high-growth knowledge industries of the future.

It is widely recognized that the United States is facing a new age of competition for leadership in an increasingly global, increasingly knowledge-based economy. *Rising Above the Gathering Storm*, the report of the National Academy of Sciences Committee on Prospering in the Global Economy of the 21st Century, recently concluded: "Having reviewed trends in the United States and abroad, the committee is deeply concerned that the scientific and technological building blocks critical to our economic leadership are eroding at a time when many other nations are gathering strength."[1]

There is no single, one-size-fits-all solution to meet this new wave of international competition. Each state must differentiate itself and build specialized areas of expertise where it can be a world leader in today's fast-paced knowledge economy. As the National Governors Association in its guidance to governors on State Leadership in the Global Economy suggests, "U.S. economic strength depends on the ability of each state to 'compete' successfully in the world marketplace. Each state must exploit the unique advantages it has relative to other states and build on the strengths found in its local 'clusters of innovation'—distinct groups of competing and cooperating companies, suppliers, service providers and research institutions."[2]

For Maryland, the bioscience cluster—building upon the presence of one of the world's leading bioscience research environments and the promise of a burgeoning bioscience industry base—is a key focus for distinguishing the state on the national and global stage. Since the early 1990s, Maryland has sustained a broad set of initiatives in support of bioscience development. In fact, Maryland had one of the first bioscience strategic plans of any state, issued

With the rise of the global knowledge economy, the technological advantage that the United States and its states and regions have enjoyed is decreasing. In contrast to the preceding two centuries in which U.S. prosperity grew as a result of technological innovation and increased productivity in the agricultural, industrial, and commercial sectors, there are troubling indicators regarding the ability of the United States to maintain similar growth in the future.

The U.S. Council on Competitiveness, *Innovate America: National Innovation Initiative Report*,* points to global trends raising concerns for the United States:

- K–12 educational performance in the United States continues to lag behind that of most competing developed nations.
- Japan, South Korea, Sweden, Finland, and Israel each spend more on R&D as a share of gross domestic product than the United States, with Asia now spending as much on nanotechnology—an emerging technology area with significant industry implications—as the United States.
- Total scientific papers by American authors peaked in 1992 and have been flat ever since.

Ultimately, we now compete and collaborate in a world in which the power of networked communications, the extended manufacturing enterprise, and access to low-wage talent have enabled the outsourcing of both lower- and higher-skilled jobs. Of particular concern is that major companies are taking advantage of the massive numbers of well-educated personnel found overseas and constructing true research centers.

*U.S. Council on Competitiveness, *Innovate America: National Innovation Initiative Report*, May 2005, pages 38 and 49.

[1] National Academy of Sciences Committee on Prospering in the Global Economy of the 21st Century, *Rising Above the Gathering Storm*, 2005, page 4.

[2] National Governors Association, *A Governor's Guide to Trade and Global Competitiveness*, 2002, page 5.

in 1991. Since that time, Maryland has put in place a wide array of bioscience initiatives that have promoted targeted enhanced research and development (R&D) with the active engagement of industry; encouraged bioscience industry networking; fostered new bioscience start-ups; enabled development of wet-lab space and dedicated bioscience research parks; and supported bioscience workforce development, bioprocessing resources, and marketing of the state's unique research environment to encourage companies to locate in Maryland.

Nearly 20 years later—with many of the same initiatives dating from the early 1990s still in place and new ones added—Maryland is now widely recognized as having one of the most advanced bioscience clusters in the world.

- Maryland ranks first among the 50 states in per capita academic bioscience R&D (fiscal year [FY] 2006) and second in per capita National Institutes of Health (NIH) awards (FY 2007).
- Maryland ranks second among the 50 states in the number of workers employed in bioscience occupations per million population (FY 2006).
- Maryland ranks second in bioscience higher education degrees awarded per million population (2006).
- Maryland ranks third in bioscience venture capital investments per million population (2002–2007).[3]

The Bioscience Opportunity

Maryland's long-standing focus on the biosciences was built on the presence of its world-class research universities and federal labs. Nations, states, and regions from across the globe—many without the significant base of world-class research institutions found in Maryland—are actively pursuing bioscience development for a number of compelling reasons:

- **The biosciences are composed of rapidly growing industry sectors**. According to latest Bureau of Labor Statistics data over the 10-year period ending in 2010, the bioscience industry is averaging annual job growth of 2.9 percent, nearly double the overall national employment growth projection of 1.6 percent annually.
- **The biosciences offer high-paying, quality jobs across a range of occupations** from technicians and manufacturing workers to research scientists and medical doctors. In 2006, bioscience workers, on average, were paid at least $29,000 more than the overall national average wage.
- **The biosciences are directed to a diversity of markets and include a number of industry sectors** with a common link—they apply knowledge of the way in which plants, animals, and humans function. The sector includes manufacturing, services, and research activities. By definition, the biosciences are a unique industry cluster and are constantly changing to incorporate the latest research and scientific discoveries. The bioscience industry sector is defined as including the following four subsectors: agricultural feedstock and chemicals, drugs and pharmaceuticals, medical devices and equipment research, testing and medical laboratories. The biosciences also contribute to the growth of other technology sectors, such as information technology, electronics, optics, and advanced manufacturing.
- **The biosciences offer states and their communities a quality of life dividend**. Investment in the biosciences can lead to benefits for a state's citizens in terms of improved health care, cleaner environments, and healthier foods.

[3] *Technology, Talent and Capital: State Bioscience Initiatives 2008*. Washington, DC: Biotechnology Industry Organization (BIO), June 2008, www.bio.org/local.

What is particularly exciting is that the biosciences are at the forefront of creativity and innovation, converging with advances in engineering, information technology, and nanosciences, to address major societal issues that have profound and significant impacts on quality of life throughout the world. Bioscience research, education, and industry activities are directly relevant to the following:

- **Human Health**—Biotechnology is a fundamental driver in the development of new drugs and biotherapeutics, disease diagnostics, vaccine development, gene and cell therapies, tissue growth, organ engineering, and personalized medicine. Also, whether by natural or terrorist means, the threat of major disease outbreaks and food contamination events is a real and present danger—and biotechnology promises solutions to these threats.
- **Food Production and Security**—With a world population of 6.7 billion people, projected to grow to over 9 billion by 2040[4], sustaining growth in food production is of paramount importance to human life. Every day more than 860 million people go hungry worldwide.[5] Agbiosciences and associated biotechnologies focus directly on finding solutions to this problem.
- **Renewable/Green Resources and Products**—Linked hand in hand with environmental sustainability is an urgent need for the development of ecologically benign resources for economic activity. Biotechnology and associated disciplines provide the expertise and resources required to develop biorenewable, biomass-based materials and products that will contribute to a sustainable, nonpolluting future. With global fossil-fuel energy prices at record levels, and legitimate concerns relating to carbon emissions from fossil fuels, the race is on to develop renewable energy sources with nominal environmental impacts. Biofuels have a substantial role to play in the supply of future global energy.
- **Environmental Sustainability**—Sustaining population growth and economic growth must be balanced with preservation of natural resources and environmental assets. The 20th century saw unprecedented growth in pollution, natural resource depletion, and environmental degradation. Biotechnology researchers are on the front lines of environmental quality and sustainability.

So, it is no surprise that many observers view the 21st century as the "Bio Century."

Maryland is Stepping Up to Meet Challenge of Staying Competitive in Bioscience Development

Not surprisingly, given the high-quality and diverse growth potential found in the biosciences, the competition for bioscience development has heated up over the years. Battelle in its 2008 report of state-by-state activities in the biosciences, prepared for the Biotechnology Industry Organization (BIO), documents that virtually every state has activities underway to support bioscience development. The BIO/Battelle report states that "State and regional economic development organizations throughout the United States are becoming increasingly sophisticated in their understanding of the biosciences and of building the biosciences sector and are adopting and implementing policies and programs that support its growth."[6] And, the competition is clearly global in nature. Ernst & Young in its 2007 annual report[7] on the state of biotechnology provided a spotlight on biotechnology activities in Europe and Asia, along with the United States.

---

[4] U.S. Bureau of the Census. "World Population Information." Online at http://www.census.gov/ipc/www/idb/worldpopinfo.html.
[5] Food and Agriculture Organization of the United Nations. *State of Food Insecurity in the World 2006*. Online at http://www.fao.org/docrep/009/a0750e/a0750e00.htm.
[6] *Technology Talent and Capital: State Bioscience Initiatives 2008*. Washington DC: BIO, June 2008, www.bio.org/local.
[7] Ernst & Young. *Beyond Borders: Global Biotechnology Report 2007*.

With the growing competition for bioscience development and the sophistication of these bioscience development efforts, it is critical that Maryland not become complacent based on its past successes. It is important that Maryland reexamine its programmatic approaches to ensure that it is well positioned for the future in the midst of fast-paced technological and industry advances.

For this reason, Governor Martin O'Malley and the Maryland General Assembly established the Maryland Life Sciences Advisory Board, composed of 15 leaders from industry, education, federal laboratories, and economic development and chaired by H. Thomas Watkins, President and Chief Executive Officer (CEO) of Human Genome Sciences, Inc. The charge to the Maryland Life Sciences Advisory Board (LSAB) is to reexamine Maryland's efforts and future directions in advancing the biosciences and provide the state with an updated, comprehensive state strategic plan to guide development of the biosciences through 2020. The LSAB organized itself into seven work groups, involving an additional 100 bioscience leaders to help in guiding the development of the updated strategic plan. Battelle Technology Partnership Practice was retained to assist the LSAB in the analysis and assessment of Maryland's competitive position, future prospects, and critical directions for development of the life sciences. The retention of Battelle was facilitated by the Maryland Technology Development Corporation (TEDCO), an independent entity created by the Maryland General Assembly in 1998 to support the creation of technology businesses and foster their growth in all regions of the state.

A 2020 VISION FOR MARYLAND IN BIOSCIENCE DEVELOPMENT—MEETING THE CHALLENGES AND SEIZING THE OPPORTUNITIES FOR GROWTH

On the high-level fundamentals, Maryland's bioscience sector shows positive signs:

- **Overall, bioscience industry employment in Maryland is growing robustly**, rising 14.5 percent from 2001 to 2006, adding 3,200 jobs, to reach more than 25,000 jobs. By comparison, the nation grew only 5.7 percent; and Maryland outpaced key competitor states such as California, Massachusetts, Pennsylvania, and New Jersey. Only North Carolina, among the bioscience elite states, outpaced Maryland's bioscience industry growth.
- **Maryland is home to one of the nation's and world's largest bioscience research complexes, notable for its federal intramural research activities and major universities as well as significant industry research activities**. Taken together, Maryland's bioscience research complex is conservatively estimated to be nearly $8 billion in R&D expenditures annually—and is third in total size only to California and New Jersey, who possess major industry R&D.
- **University bioscience research grew substantially**. From 2002 to 2007, Maryland's life science research base grew 44.2 percent from $877,598 to $1.3 billion. This rate of growth was greater than the 41.6 percent national rate over the same time period.
- **Maryland remains a talent magnet in the biosciences**. Maryland has one of the most significant concentrations of highly trained bioscience research scientists in the world. This rich talent base is one of Maryland's major assets in the biosciences—and remains an anchor for future bioscience development.

Despite these positive fundamentals, the most striking aspect of Maryland's current position is the still untapped potential of its bioscience base. While Maryland remains one of the leading centers for bioscience research—with sizable and high-quality university research efforts and the nation's largest concentration of federal laboratory bioscience research funding—its overall bioscience industry development still does not measure up to this base of research activity.

Even with the continued bioscience industry gains, Maryland is still less developed in its bioscience industry base than leading competitor states. One specific measure of industry development is the concentration of that industry within a state's economy compared with the nation. Those states that are highly developed in a particular industry will have a greater concentration of employment in that industry than is found in the nation. For a state to be regarded as specialized in a given industry requires a 20 percent higher concentration in jobs in that industry than is found in the nation. The leading bioscience competitor states of California, Massachusetts, New Jersey, North Carolina, and Pennsylvania all have at least a 30 percent greater concentration than the nation in the biosciences. With a mere 7 percent higher level of concentration, Maryland is not yet specialized overall in the biosciences.

Maryland's success in bioscience industry development is found in the R&D component of the overall bioscience sector. With just over 12,000 jobs, the bioscience R&D subsector represents nearly half of Maryland's overall bioscience industry employment and accounted for 69 percent of the state's growth in bioscience jobs from 2001 to 2006. Maryland is clearly a national star in bioscience R&D, with an employment concentration nearly twice the national average.

Only Massachusetts among large bioscience states is more specialized than Maryland in its bioscience R&D. But, unlike Massachusetts, which also has a large and specialized medical device sector, Maryland's only other specialized bioscience industries are the more niche and smaller industries of *in vitro* diagnostics, with 2,400 jobs, and biological processing, with 1,527 jobs.

Looking to the future, the bioscience R&D industry can be viewed as the pipeline for creation and early growth of innovative bioscience companies. While many of these bioscience R&D companies provide research services to federal labs, universities, and other bioscience companies, a significant number are focused on the development of new products, but have not yet been able to complete product development or win regulatory approval to bring their products to market. As these product-oriented bioscience R&D companies succeed, they will enter more established product-oriented subsectors of the bioscience industry, such as diagnostics, therapeutics, and devices.

Many of these product-focused bioscience R&D companies are located in Maryland to be close to the state's research complex, because they are seeking to commercialize discoveries made at Maryland's research institutions, tapping key talent or collaborating with these research institutions. In fact, Maryland receives the highest level of R&D funding to industry from the federal government of all the states, and these federal funds to industry for research are by far the largest source of funding for industry research activities in Maryland.

The challenge for Maryland in developing its bioscience industry is to foster an environment that can help these product-oriented bioscience R&D companies succeed in developing their products and bringing them to market. In the years ahead Maryland needs to work harder and smarter to accelerate the rate at which its research strengths translate into viable start-up bioscience companies that seek to bring products to market, while at the same time facilitating the success and continued advancement of high-growth bioscience companies that are beyond the start-up phase and pushing to become enterprises able to sustain over the long term. Access to capital, facilitation of product development support, and availability of strategically targeted precommercialization and translational research resources are all essential to helping Maryland's product-focused bioscience R&D companies evolve into the thriving, job-creating engines of product innovation and market strength that some of them can become.

As these product-oriented bioscience companies advance, they also generate opportunities for Maryland to attract leading global bioscience industry companies to operate in Maryland. A commonplace occurrence in bioscience industry development, especially for emerging product-oriented bioscience R&D companies, is to merge or be acquired by larger bioscience businesses. To the extent that Maryland bioscience companies offer a strategically important new line of business or capability to larger companies, there is an excellent chance that these global bioscience companies will remain to grow and expand their presence in Maryland. Notable global companies to enter Maryland recently include AstraZeneca through the acquisition of MedImmune, Teva through the acquisition of CoGenesys, and Qiagen through the acquisition of Digene. So, an excellent bioscience business development strategy, both for organic growth and for attracting important new entrants to Maryland, is to facilitate the evolution of product-focused bioscience companies beyond the R&D stage, to the stage where they succeed in advancing their products to commercialization.

The potential is limitless, but the road ahead will not be easy. It will require vision and a high level of focus, determination, and willingness to invest for Maryland to realize its full potential to compete on a global level and grow its leadership in the biosciences. And there are some challenges that must be dealt with effectively for this vision to become reality:

- Bioscience venture-capital investment in Maryland has fallen off sharply now for two consecutive years. A close examination reveals that significant venture-capital funds are under management in Maryland, but these funds are not being invested in Maryland-based companies.
- The nation's willingness to fund bioscience research appears to be falling off. NIH's budget has failed to keep up with inflation, and the prospects in the next few years do not seem bright. On a single year-to-

year change, Maryland universities actually realized a decline in research funding from 2006 to 2007, after recent years of strong growth. This trend requires close attention.

- The climate for innovation and industry partnerships with federal labs, particularly NIH, has been negatively affected by concerns about conflict of interest—although current statistics show improvement. Partnerships between NIH investigators and industry, as measured by the number of cooperative research and development agreements (CRADAs), hit a new low in 2007, although in 2008 they returned almost to 2005 levels. Perhaps reacting to perception rather than fact, stakeholders are nonetheless concerned that it will continue to be more difficult for industry to engage with NIH researchers to advance translation and commercialization of NIH discoveries.
- Immigration policies threaten the ability to attract the best and brightest from across the world to join Maryland's research universities and federal labs.

The LSAB has developed the following vision for Maryland's bioscience future.

A 2020 Vision for Maryland's Bioscience Development

By 2020, Maryland will be globally renowned for its ability to translate its world-class bioscience research capabilities into viable and highly regarded product-oriented bioscience companies that establish new industry strengths in therapeutics, diagnostics, devices, and innovative biobased products.

Maryland will continue to advance its leading bioscience research complex and, through strategic investments and innovative programs, leverage the discoveries and talent it generates to create a high-quality environment for the accelerated growth and success of bioscience companies in Maryland.

Maryland will be clearly recognized as one of the top tier states highly specialized in overall bioscience development.

The next section of this report outlines a set of strategic priorities and actions to be implemented during the next 10 years to achieve this vision.

STRATEGIC PRIORITIES AND ACTIONS

Four strategic priorities and 17 specific actions are recommended by the LSAB to move Maryland forward toward its 2020 vision for the development of its bioscience industry. The strategic priorities include the following:

- One: Ensure the sustained growth and future competitiveness of Maryland's bioscience industry.
- Two: Support the creation and growth of innovative bioscience companies by ensuring access to capital.
- Three: Position Maryland for global leadership in cutting-edge areas of the bioscience research and emerging growth markets.
- Four: Advance bioscience talent generation and workforce development.

These strategies and the actions proposed to achieve them are outlined in Figure 1. It is anticipated that most of these actions would be implemented over a 10-year time period extending to 2020.

Figure 1. Overview of strategic priorities and actions to develop Maryland's bioscience industry

Ensure the Sustained Growth and Future Competitiveness of Maryland's Bioscience Industry	Support the Creation and Growth of Innovative Bioscience Companies by Ensuring Access to Capital	Position Maryland for Global Leadership in Cutting-Edge Areas of Bioscience Research and Emerging and Growth Markets	Advance Bioscience Talent Generation and Workforce Development
■ Establish the Maryland Biotechnology Center to serve as a catalyst and central resource for spurring growth ■ Establish the BioEntrepreneur Resource Program to provide one-stop assistance to bioscience entrepreneurs and emerging companies ■ Strengthen and advance BioMaryland – Maryland's bioscience brand ■ Develop 21st century bioscience industry infrastructure in Maryland	■ Expand the Maryland Biotechnology Investor Tax Credit ■ Make permanent and expand the R&D tax credit and make it refundable to small bioscience companies ■ Establish the Maryland Life Sciences Venture Capital Trust to advance investment in Maryland bioscience companies by pension and venture funds ■ Ensure the availability of product development capital for emerging bioscience companies	■ Strengthen technology transfer at research universities and the ability to launch bioscience ventures based on university research ■ Establish Bioscience Commercialization Institutes in Maryland ■ Expand the Maryland Industrial Partnerships Program (MIPS) ■ Invest in emerging fields of bioscience research ■ Establish the Maryland Federal Lab Engagement and Collaborative R&D Program ■ Support university and community college bioscience development projects	■ Advance a systematic and coordinated statewide approach to developing bioscience career pathways ■ Create the Maryland Bioscience Industry Workforce Skill Development Fund ■ Develop and retain bioscience scientific and entrepreneurial talent

Strategic Priority One: Ensure the sustained growth and future competitiveness of Maryland's bioscience industry

Action One: Establish the Maryland Biotechnology Center to serve as a catalyst and central resource for spurring growth of the bioscience industry in Maryland

Rationale: The centerpiece for implementing the actions recommended by the LSAB is the creation of a Maryland Biotechnology Center (MBC). This Center is critical to bring a more integrated statewide focus to the state's bioscience development efforts, address the fragmented maze of programs that have emerged over the past 15 years, and create a results-driven approach that can propel Maryland's bioscience efforts forward as a model for the 21st century. Maryland has lacked an organizational focus to advance development of the Maryland bioscience cluster. The state has a rich environment of innovative and leading bioscience companies, world-class bioscience research institutions, and a significant base of bioscience talent; but, it needs to be a more integrated, highly functioning community to succeed in the future and seize its untapped potential.

Maryland is a recognized global leader in bioscience discovery and innovation. The state is home to more than 370 bioscience companies—one of the largest and fastest-growing clusters of such companies in the world. It has a rich environment of world-class federal and academic bioscience research institutions and a significant base of bioscience talent. The growth of the Maryland bioscience industry to date has been fueled by a combination of federal, state, and private investment. Maryland has been a global leader in the pace of growth in its bioscience industry; but, the pace of growth has slowed recently compared with peers in the important subsector of bioscience R&D, which represents nearly half of Maryland's overall bioscience industry employment and accounted for 69 percent of the state's growth in bioscience jobs from 2001 to 2006.

States, in the aggregate, are spending billions of dollars to support bioscience research and infrastructure and to encourage the development and growth of their biotechnology and bioscience sector. California, Massachusetts, North Carolina, and Pennsylvania—to name a few—are investing hundreds of millions of dollars or more to encourage investment in bioscience companies, research, and infrastructure. A number of states, including Massachusetts and North Carolina, have established statewide biotechnology centers or other statewide central resources to provide guidance and coordination to efforts to develop and grow the bioscience industry in their states. The scope of responsibility and authority given to such centers varies; but, the core motivation for creating them is similar from state to state. The 21st century has been named the "Bio Century" by a number of business publications, think tanks, and consultancies because of the explosive potential of bioscience technology to generate game-changing advances in sectors ranging from pharmaceuticals to chemicals to agriculture to clean fuels and countless others. The opportunity for improvement of human life is unique. The opportunity to generate economic growth and job creation is substantial. Many

North Carolina Biotechnology Center

The North Carolina Biotechnology Center is a private, nonprofit organization created by the North Carolina legislature in 1984. The Center is dedicated to developing the biotechnology sector statewide by supporting research, business, and education. NCBC provides funding for collaborative research projects, financial assistance in the form of grants and loans to early-stage bioscience companies, and support for an array of bioscience education initiatives.

The portfolio of programs NCBC can offer include business loans up to $50,000 targeted at early-stage companies trying to meet commercialization milestones; up to $150,000 as a bridge between Small Business Innovation Research (SBIR) Phases I and II; up to $250,000 to match angel investment at the post–proof-of-concept stage; and up to $350,000 to support applied research in product development. The NCBC also offers portals and other assistance aimed at connecting early-stage companies with larger corporations, venture financiers, angel capitalists, and university licensing offices; an industrial fellowship (see elsewhere); monthly networking forums and an annual in-state biotech conference; listings of available commercial wet-lab space; and entrepreneurial education produced in cooperation with the Council for Entrepreneurial Development and the state Small Business and Technology Development Center.

The total budget of NCBC in FY 2006–2007 was $17.6 million, of which $13.1 million came from a state appropriation.

states and countries want to be players in biotechnology and the bioscience industry, and the competition is growing.

Over the past 15 years, Maryland has created a number of programs to foster technology transfer, the creation and nurturing of new bioscience companies, formation and access to capital, support for bioscience research and infrastructure, academic–private-sector partnerships, and workforce development. Yet today, these programs are fragmented and spread across multiple state agencies and other organizations. Private-sector initiatives with similar or complementary missions, while in a number of cases highly effective, are similarly spread across multiple organizations. The LSAB believes that the programs offered by the State of Maryland could be even more productive and effective if they were better coordinated, better funded, more strategically designed, and better communicated—and further believes that private-sector initiatives would similarly benefit if a central resource existed to increase awareness within the Maryland bioscience industry.

Proposed Activities: The LSAB proposes that the MBC be established to coordinate and, in certain instances, consolidate Maryland support for the continued growth and success of the bioscience and biotechnology industry in the state. Working closely with industry partners, the MBC will concentrate on efforts to help create new bioscience enterprises, sustain the growth of successful bioscience enterprises, and leverage the state's unique life science assets in the academic and federal sectors to advance Maryland's position as a global biotechnology leader.

Massachusetts Life Sciences Center

The Massachusetts Life Sciences Center (MLSC) is a quasi-public agency created by the Massachusetts legislature in 2006. The MLSC is closely affiliated with the Massachusetts Executive Office of Housing and Economic Development but is not subject to its direct supervision or control. The mission of MLSC is to promote the life sciences within the Commonwealth of Massachusetts by investing in life science research and economic development. The MLSC is tasked with overseeing implementation of Massachusetts' 10-year, $1 billion Life Sciences Initiative, which includes financing for university R&D facilities, bioscience research, and a set of tax credits directed at bioscience companies.

The MBC would initially be created within the Maryland Department of Business and Economic Development (DBED), and funded by DBED. It would be led by an Executive Director and advised by the LSAB.

Over time it is critical to ensure that the continuity and focus of the MBC can be sustained and gain broad support of key stakeholders. To make this possible, the LSAB recommends that the MBC become a quasi-public development entity similar to many of the leading state technology development organizations across the nation, including the NCBC, the Ben Franklin Centers in Pennsylvania, the Massachusetts Technology Collaborative and the newly formed Massachusetts Life Sciences Center, and Maryland's own TEDCO. As a quasi-public entity, the MBC would still be accountable to Maryland's elected officials and would still receive funding from Maryland state government, but it would have more stability over election cycles and could establish the meaningful ties to the bioscience community that will allow it to be a trusted central resource and catalyst.

The MBC's role will vary from recommendation to recommendation; the MBC may have direct programmatic responsibility, share programmatic responsibility with other agencies or institutions, or simply provide funding for programs administered by others. The MBC would have responsibility for the following major programs and initiatives:

- **Coordination of ongoing Maryland activities in support of the bioscience sector** to enhance their reach and customer service focus and to ensure sharing of information across all segments of the bioscience community.
- **Creation and administration of the BioEntrepreneur Resource Program**, which would provide one-stop assistance to bioscience entrepreneurs and early-stage companies in obtaining access to capital; assistance with workforce development; and navigating financial, legal, and financial hurdles (see Action 2).

- **Administration of the expanded Maryland Biotechnology Investment Tax Credit**, which encourages investment in Maryland biotech companies (see Action 5).
- **Creation and administration of the Maryland Bioscience Translational Research and Commercialization Initiative**, which would include establishing the **Maryland Bioscience Commercialization Institutes** to provide the specialized translational R&D infrastructure required to accelerate and retain commercialization activity in Maryland (see Actions 9 and 10).
- **Leading the creation of the Maryland Life Sciences Venture Capital Trust** to advance investment by pension and venture funds in the Maryland bioscience industry (see Action 7).
- **Creation and administration of the Maryland Bioscience Product Development Loan Fund**, to address a significant gap in Maryland's support for emerging bioscience companies (see Action 8).
- **Advancing bioscience career pathways and workforce development through investment in education and training** and by working closely with biotechnology companies to develop appropriate curricula in biotechnology and manufacturing (see Actions 15-17).
- **Facilitation of partnerships, alliances, and networking activities**—through initiatives to link Maryland's bioscience companies with one another, sources of capital, service providers, and the state's federal and academic life science institutions.
- **Building the BioMaryland brand and marketing Maryland on a national and global basis** to ensure that Maryland's leadership position in the biosciences is recognized and continues to grow (see Action 3).
- **Monitoring progress in planning and implementation of Maryland's bioscience agenda**, measuring how the state is doing, identifying gaps and needs, and ensuring a results-driven approach to bioscience development in the state.

Resources Required:

Annual base funding of $6 million is proposed, with scheduled increases to $8.5 million in FY 2013–FY 2015 and to $12.0 million in FY 2016–2020. This will allow the MBC to keep up with increases due to inflation and growing demand for services.

Performance Measures:

- Percent of bioscience companies served
- Cycle time to receive assistance
- Client satisfaction as determined by surveys
- Achievement of the objectives of programs for which the Center would be responsible

Lead Organization(s):

The MBC will initially be housed within DBED.

Action Two: Establish the BioEntrepreneur Resource Program to provide one-stop assistance to bioscience entrepreneurs and early-stage companies

Rationale: Services and support programs offered by the State of Maryland and others to bioscience entrepreneurs and early-stage companies in the state—although often highly effective—are fragmented, unnecessarily difficult to identify, and require too much paperwork for applications and reporting. To bring a bioscience product to market—whether a therapeutic, diagnostic, medical device, agbio, or industrial biotech product—an entrepreneur or early-stage company must discover, invent, or acquire rights to intellectual property that can be developed into a commercializable product or technology; assess the likely market and requirements for commercial success; develop a business plan that stands up to scrutiny by potential investors or partners; protect the underlying intellectual property through patents or licenses; develop a prototype and demonstrate proof of concept; prepare a marketing and sales plan; find appropriate collaborators and partners; recruit and retain talent; scale up for manufacturing; and, ultimately, undertake actual product distribution, sales, and marketing. Entrepreneurs also must be able to attract sufficient capital to fund these activities in order to turn a product concept, technology, or service into a business that can grow, prosper, employ people, and make an economic contribution to the people and State of Maryland.

The LSAB believes that a need exists for a "one-stop shop" to provide assistance from staff that is comprehensively skilled in the particular needs of biotechnology and life science enterprises. One best practice example is i2E, a nonprofit commercialization center funded by the Oklahoma Center for Advancement of Science and Technology. i2E puts Oklahoma start-ups through a highly structured, six-stage commercialization model and provides access to a qualified business resource network. Successful graduates of the commercialization process are introduced by i2E to a statewide network of angels. i2E reports as an evaluation metric that it has interviewed 1,100 companies since 1998, assisting half. Some 300 companies have made it through the structured process, of which 100 have secured more than $261 million in state, informal, and formal investment capital.

i2E—Oklahoma Technology Commercialization Center

i2E, a nonprofit center funded by the Oklahoma Center for Advancement of Science and Technology, assists Oklahoma technology start-ups through a highly structured, six-stage commercialization model with access to entrepreneurial mentors and a network of qualified professional service experts. i2E also enables emerging technology companies to access public capital programs, including the Technology Business Finance Program, through which companies can apply for up to $100,000 annually for commercialization activities including R&D, prototype creation, equipment purchase, and even creation of marketing materials. Successful graduates of the commercialization process and TBF may be introduced to the Oklahoma Seed Capital Fund, which can make up to 10 equity investments a year in the range of $250,000 to $700,000 each. Significantly, i2E also offers access for qualified companies to access to its own statewide network of angels. i2E reports as evaluation metrics that it has assisted more than 550 companies since 1998, with 300 companies making it through the structured process, of which 100 have secured more than $261 million in state, informal, and formal investment capital.

Proposed Activities: Establish the BioEntrepreneur Resource Program to provide one-stop assistance to bioscience entrepreneurs as a priority focus of the MBC. The purpose of the BioEntrepreneur Resource Program is to improve the quality of deal flow, link bioscience entrepreneurs to key support resources, and stimulate early-stage private investment by state sources, angel investors, and venture capital funds. The Program would focus its entrepreneurial service on the intensive process of vetting new bioscience ventures by using a structured commercialization assistance model to provide day-to-day support to entrepreneurs. The Program would bring a strong focus on understanding technologies and markets for core bioscience areas in Maryland through its staff expertise and would not seek to become a general entrepreneurship center. Through its BioEntrepreneur Resource Program, the MBC would offer the following:

- **One-stop help with access to sources of capital**. MBC staff will help assess the financing needs of the emerging bioscience company based on the milestones they have reached, the market potential and competitor analysis, and other key factors. The MBC would serve as a central point of contact for bioscience entrepreneurs and emerging companies seeking financing from any of Maryland's early-stage

financing programs. The MBC would also serve as a central source of information regarding federal grants for which emerging companies might be eligible. The MBC would match bioscience entrepreneurs and emerging companies with the most appropriate funding source and assist in completing necessary paperwork to apply for funding. The BioEntrepreneur Resource Program will link emerging firms to early-stage capital sources and will link firms seeking to expand to programs such as the Maryland Economic Development Assistance Authority and Fund (MEDAAF) and the Maryland Industrial Development Financing Authority (MIDFA). In addition, MBC will also seek to assist Maryland bioscience entrepreneurs and emerging companies with federal sources of funding, such as the federal SBIR program, CRADAs, and other federal grant programs.

- **Ready access to expertise of knowledgeable bioscience business service providers**—Access to high-quality, locally accessible, and reliable service providers who understand the needs of biotechnology and life science companies is crucially important—including regulatory assistance, clinical and preclinical research, and other technical services, as well as financial and general business services. The BioEntrepreneur Resource Center would link entrepreneurs and providers of support services.
- **Programs to encourage active entrepreneur and investor networking**—The MBC would develop a strong knowledge base of local bioscience investors in Maryland and would routinely introduce qualified bioscience entrepreneurs to investors and to other entrepreneurs, both individually and through networking programs facilitated by the MBC both directly and in collaboration with other organizations such as MdBio and Capital Access Network. The MBC would also help first-time entrepreneurs prepare and rehearse "elevator pitches" and investor presentations.
- **Assistance with permitting processes, regulatory hurdles, and unnecessarily bureaucratic impediments**—by providing a knowledgeable source of information and, where necessary, linking entrepreneurs to experts able to help them with the specific problem they face.
- **A source of information and assistance on business formation, intellectual property, and other legal issues** important to bioscience entrepreneurs and early-stage companies.
- **Assistance with workforce development**, serving as a central portal for access to sources and development of talent across Maryland.

Resources Required:

The BioEntrepreneur Resource Program will require an annual budget of approximately $1.5 million, primarily for staff support, development of incentives for certified resource networks, marketing, and outreach. This budget is included in the $6 million budget of the proposed MBC (see Action 1).

Performance Measures:

- Firms assisted
- Leveraged funds
- Client satisfaction as measured by client surveys
- Jobs created
- New products introduced and sales generated
- Business survival metrics (e.g., 5 year)

Lead Organization(s):

The BioEntrepreneur Resource Program will be provided by the MBC (see Action 1).

Action Three: Strengthen and advance Maryland's biotechnology brand

Rationale: With a recognized global leadership position in bioscience discovery and innovation, and one of the nation's largest clusters of biotechnology companies, Maryland is now emulated by other states wishing to jump-start their biotechnology industry. Maryland has been a global leader in the pace of growth in its bioscience industry, although the pace of growth has slowed recently compared with peers in the important subsector of bioscience R&D. In marketing for bioscience industry development, it is important to recognize that the opportunities in the biosciences are actively being pursued by many regions across the nation, as well as by other countries. For Maryland to distinguish itself in this increasingly competitive environment, it must ensure that it is addressing the needs of its current bioscience companies, while also aggressively pursuing new opportunities that fit well strategically. It is clear, even with Maryland's many competitive advantages, that success in intelligently growing Maryland's bioscience industry into the future will require careful differentiation from other states and regions—and a first-class program of branding and marketing.

The LSAB believes that the BioMaryland brand would benefit from a focused projection of message and identity that more effectively differentiates Maryland from its competitors in the United States and abroad. It is important to demonstrate and communicate that companies and institutions coming to Maryland will find a supportive environment in which they can thrive in finding the talent, research, and commercial relationships and access to capital and specialized facilities that are critical to growing a successful bioscience company.

Research Triangle and St. Louis Branding

Best practices in bioscience marketing call for an "alliance" approach coupled with strong internal marketing. An active alliance marketing program brings together the state, county, and local economic development organizations; universities; local bioscience industry organizations; and companies to recruit outside investments and new business expansion. Alliance-related activities include active presence at trade shows, overseas and other trade missions, and even developing sister-state/sister-city relationships.

Two areas that have been very successful in using these approaches are Research Triangle and St. Louis. In North Carolina, the NCBC helped to identify and recruit life science companies with fly-ins of executives, and tours with strong industry and university involvement. St. Louis has formed a Coalition for Plant and Life Sciences in close partnership with the St. Louis Regional Chamber and Growth Association (RCGA) that enables highly coordinated outreach marketing involving universities, incubators, professional organizations, and others.

But, what makes an alliance marketing approach possible is an active focus on internal marketing to build the needed community support and enable all key segments of the community to be involved in the outreach effort. Internal marketing for North Carolina included outreach to local schools in promoting life science careers and active news stories on life science industry developments. St. Louis has had great success in its internal marketing through the use of networking as well as utilizing the RCGA's Technology Gateway Life Sciences Network.

Proposed Activities: The MBC would be the ideal organization under which to consolidate responsibilities for marketing the BioMaryland brand. The LSAB recommends that the MBC take the lead in developing and implementing a coordinated and defined branding and marketing campaign in conjunction with the state's existing regional economic development organizations, such as the Tech Council of Maryalnd/MdBio, the Greater Baltimore Alliance, and county economic development offices. This would include raising the visibility of BioMaryland in the biotechnology and life science industry at national and global levels, generating and qualifying prospects, coordinating the "BioMaryland Leader to Leader" initiative, engaging leaders in the Maryland bioscience community as "BioMaryland Partners," and assisting DBED in its packaging of deals to qualified prospects. This will require a dedicated marketing program and knowledgeable staff within the MBC, along with resources for key programmatic activities. The marketing initiatives to be undertaken by the Center would include the following:

- **Branding Campaign**: The MBC would bring key bioscience stakeholders together to ensure that the branding and marketing campaign is developed with the strong consensus-based support of the bioscience community. The MBC would retain an experienced professional marketing/public relations

firm to work with MBC staff to develop and execute a marketing/public relations program to strengthen the BioMaryland brand and gain recognition for the many benefits of locating bioscience companies and institutes in Maryland.

- **"BioMaryland Leader to Leader"**: The MBC would establish the "BioMaryland Leader to Leader" initiative to strengthen and integrate existing relationships between Maryland bioscience industry leaders and corporate prospects in other regions and countries to assist DBED's bioscience industry attraction efforts. The "Leader to Leader" initiative would coordinate formal contacts, speaking invitations, and opportunistic tours of Maryland's life science assets. The MBC would also leverage the state leaders as ambassadors to leverage high-level relationships, including the Governor and Lt. Governor, to grow Maryland's reputation as a leader in the life sciences.
- **"BioMaryland Partners"**: The MBC would also create a statewide network of knowledgeable industry volunteers—"BioMaryland Partners"—who would serve as on-call ambassadors for Maryland's bioscience community. BioMaryland Partners would attend senior-level meetings, host events, and sponsor tours to promote Maryland to corporate prospects considering where to locate or expand operations. The Center would also work closely with its BioMaryland Partners, DBED, and other stakeholders to develop a consensus as it develops the BioMaryland brand and marketing strategy, and to improve opportunities for attraction of corporate prospects. Committed to growing the life sciences in the state, BioMaryland Partners would bring together a group of life science leaders from companies and research institutes throughout the state to partner with DBED in more effectively marketing to prospective companies.

Resources Required:

The branding campaign would be funded at $500,000 per year for initial branding and follow-on earned media, outreach at targeted industry trade shows, developing conferences, etc., with increases over time to keep up with inflation. The combined cost of the "Leader to Leader" and "BioMaryland Partners" initiatives would total approximately $100,000 for out-of-pocket expenses for meetings, materials, and events (included within the MBC budget proposed in Action 1). It is recommended that the budget for branding and marketing continue to increase with the proposed increases in the funding for the MBC—and to $850,000 in FY 2013–FY 2015 and to $1.2 million in FY 2016–2020.

Performance Measures:

- Awareness of Maryland brand (periodic survey of key industry leaders)
- Media placements on Maryland brand
- MBC monitoring of DBED's internal statistics on qualified bioscience leads generated, prospects identified, and deals closed

Lead Organization(s):

The MBC would work in partnership with regional and local economic development organizations including the Tech Council of Maryland/MdBio, the Greater Baltimore Alliance, and county economic development agencies.

Action Four: Develop 21st century bioscience industry infrastructure in Maryland

Rationale: Increasingly, states and regions are focusing on the physical environment in which the growth of technology-based industries takes place. There is a growing recognition that, in today's global, knowledge-based economy, the factors that drive location decisions are rapidly shifting. In the past, a region's natural resources and proximity to markets were the most critical factors. But, with the rising importance of knowledge workers and innovation, a state or region's competitiveness for technology-based growth depends on its ability to generate, attract, and retain talent and to create physical environments that facilitate industry and university interactions. More and more man-made factors that impact quality of life as well as the depth and openness of a state or region's universities to industry collaboration are critical factors for development.

Maryland's Incubators

Maryland has invested $6.7 million to develop a network of 19 technology incubators, about one-third of which have wet-lab space. A study conducted by Research Triangle Institute for Maryland TEDCO in 2007 found the tenants and graduate companies of these incubators resulted in more than 14,000 total jobs in 2006 and contributed $1.2 billion in gross state product and $100 million in state and local taxes.* The study found that, among bioscience incubator companies, the need for customizable and affordable wet-lab facilities was their number one issue upon graduating from the incubator. The study also found that Maryland has the potential to support additional incubators. As of June 2008, the 18 fully operational incubators had an average occupancy of nearly 90 percent, with eight incubators at 95 to 100 percent capacity.

*News release available at http://www.rti.org/news.cfm?nav=144&objectid=3166.

Bioscience firms, in particular, tend to cluster close to each other and to other research institutions, including universities and academic medical centers. In addition to wanting to be close to their collaborators, they also require access to wet-lab space, shared equipment, and business services. States and regions seeking to grow their bioscience cluster realize that they must invest in the physical infrastructure to provide an attractive location for their bioscience companies and research institutions.

Maryland recognized early on the importance of providing an appealing physical location to attract and grow bioscience companies. In the 1980s, the Shady Grove Life Sciences Center became the first business park in the nation to be dedicated exclusively for the life sciences. In the 1990s, both the University of Maryland and Johns Hopkins University (JHU) established educational facilities in the Park. Today, the Park is home to more than 200 private firms with more than 4,500 employees. It also includes health care facilities, R&D centers, laboratories, and a business incubator.

Research parks, all of which include a bioscience focus, are under development at the University of Maryland in College Park (UMCP), University of Maryland-Baltimore (UMB), University of Maryland-Baltimore County (UMBC), JHU in East Baltimore, and Montgomery College in Germantown. Maryland has developed a network of incubators that support bioscience and other technology start-ups and is investing in new educational facilities and equipment to house biotechnology education programs. Continued investment will be required to advance these initiatives and to continue to grow Maryland's bioscience hubs.

Proposed Activities: Maryland has a number of regions that are already home to or have emerging bioscience industry clusters. Investments will need to be made in facilities, transportation, and housing to ensure that these regions remain attractive to bioscience companies and bioscience workers. In addition to these general infrastructure investments, the LSAB makes the following proposals:

- Maryland's incubator development fund should be reestablished under the administration of TEDCO to allow incubator feasibility studies and provide capital to those found to have the greatest opportunity for succeeding.
- Maryland should continue to use its existing economic development programs, such as MEDAAF and MIDFA to support tenant fit-out of wet-lab space as needed.
- Maryland and its universities should continue to invest in fostering bioscience clusters of industry, research, and education activities at targeted sites throughout the state through the development of

mixed-use research park campuses that house bioscience companies, educational facilities, and research operations.

Resources Required:

It is proposed that $2.0 million annually be allocated to the Maryland incubator support fund. No additional resources will be required beyond DBED's existing economic development programs.

The MBC would work with DBED, local economic development organizations, and the state's universities and federal laboratories to assess the need for additional investment in bioscience multitenant facilities and new and expanded multi-use research park developments and work to raise funding for such development projects as needed in concert with universities, federal labs, and developers.

Performance Measures:

- Employment in incubator tenant and graduate companies
- Net new square feet of wet-lab space in multitenant buildings
- High incubator occupancy rates

Lead Organization(s):

TEDCO has the responsibility for administering the incubator development program. The MBC working with DBED should work with companies to ensure that financing is available for the development of additional wet-lab space as needed. MBC should work with local economic development organizations and research parks to promote mixed-use development that incorporate space for research growth, multitenant facilities, and housing and other amenities.

Strategic Priority Two: Support the creation and growth of innovative bioscience companies by ensuring access to capital

Action Five: Expand the Maryland Biotechnology Investment Tax Credit

Rationale: Maryland's Biotechnology Investment Tax Credit Program provides income tax credits for investors in qualified Maryland biotechnology companies. This tax credit program was passed to offer incentives for investment in seed and early-stage, privately held biotech companies. The value of the credit is equal to 50 percent of an eligible investment made in a qualified Maryland biotechnology company during the taxable year. The maximum amount of the credit cannot exceed $50,000 for individual investors and $250,000 for corporate investors. The total amount of initial credit certificates issued in each fiscal year cannot exceed the amount appropriated to the reserve fund in the state budget. A Qualified Investor is an individual or any entity who invests at least $25,000 in a Qualified Maryland Biotechnology Company. A Qualified Maryland Biotechnology Company is a company that (1) has its headquarters and base of operations in the State of Maryland, (2) has fewer than 50 employees, (3) has been in active business no longer than 10 years (12 years if approved by DBED), and (4) has been certified as a biotechnology company by DBED.

Wisconsin Angel Investor Tax Credit

Wisconsin was highlighted by both the National Governors Association (NGA) and Angel Capital Association (ACA) as having an angel tax credit that is well integrated with the state's overall efforts via the Wisconsin Angel Network to support statewide development of regional angel funds or groups. The program offers 25 percent credit against personal income tax for investment in qualifying companies. The individual tax payer is capped at $500,000 in equity investment, and the overall program is capped at $3 million a year or $30 million over the 10-year authorization. The targeted companies may be in a wide range of sectors (including, but not limited to, bio) with fewer than 100 employees more than half of whom live in-state

Based on a review of experience to date, the LSAB believes that the Biotechnology Investment Tax Credit Program has been highly successful in encouraging individual "angel" investors to invest in Maryland biotechnology companies. Demand for the program greatly exceeds the current annual $6 million cap as evidenced by the fact that investors waited in line for as many as 17 hours to apply for the $6 million in credits that became available on July 1, 2008.[8]

Proposed Activities: The LSAB proposes (1) that the amount appropriated to the reserve fund in the state budget for the Maryland Biotechnology Investment Tax Credit be raised from $6 million to $12 million as quickly as feasible, and then in increments to $24 million in total annual funding by 2020; and (2) that the amount available to any single qualified company be limited to no more than 10 percent of the total funds available in the year in which the credit is awarded..

Resources Required:

It is proposed that the cap be increased from $6 million to $12 million as quickly as feasible and then in increments to $24 million by 2020.

Performance Measures:

- Firms assisted
- Dollars invested in biotechnology companies
- Jobs created
- Business success indices (employment growth, products or services, survivability)

Lead Organization(s):

The MBC would be responsible for administering the expanded Biotechnology Investment Tax Credit.

[8] "Biotech Start-ups Covet Tax Credit," *Washington Post*, July 7, 2008.

Action Six: Make permanent and expand the R&D Tax Credit and make it refundable to small bioscience companies

Rationale: A clear majority of states now offer some variation of a research-activities credit against corporate or personal-income tax liability. These credits are offered using the same general definitions as the federal credit, with minor tweaks and only for research conducted in-state. Despite Maryland's global recognition for its R&D strength, the state's tax credit program is subject to renewal. At the last renewal cycle, the program was almost eliminated entirely, calling into question the state's commitment to one of its recognized assets.

Maryland's research-intensive companies are eligible to receive the state's R&D tax credit annually, representing almost $1 billion in eligible R&D expenses. Maryland's R&D tax credit rate is 3 percent for basic R&D expenditures and 10 percent for growth R&D expenditures, making it the lowest among the benchmark states identified by the LSAB (California, Massachusetts, Pennsylvania, North Carolina, and New Jersey). Furthermore, the Maryland R&D tax credit is capped at $3 million each for the basic and growth components. When applications exceed the cap, the credits are prorated across the eligible companies. As a result, the companies making the largest investments, which tend to be the larger companies, receive a large percentage of the credit. An analysis of the Maryland's R&D Tax Credit Program from 2001 to 2006 for which data are available reveals that 50 percent of participating companies receive credits of $20,000 or less, causing small firms to question whether it is worth the cost of application and reporting requirements. The average Maryland R&D tax credit oversubscription is sevenfold, meaning that companies are receiving only $1 for every $7 of credit for which they qualify. Currently, bioscience companies account for about 40 percent of the credit awards and 52 percent of the credit funds.

A few states have made their granted R&D tax credits refundable or transferable, i.e., a company that qualifies for the state R&D credit can obtain it in cash even if it has no overall tax liability to be offset by the credit. Since many bioscience firms lose money and have no tax liability for many years during the discovery and development cycle, this ability to accept R&D tax credits as refunds can be significantly more attractive than even a lengthy carry-forward for unused credits. A refundable credit to a company that qualifies is effectively a cash injection and a substitute for a certain amount of other kinds of financing.

Examples of Innovative State R&D Tax Credit Programs

Connecticut has an R&D tax credit that is generous, simple, *and* refundable under certain circumstances. The state offers a "nonincremental" credit of between 1 percent and 6 percent on qualified research expenditures (federal definition), scaling upward with the level of expenditure, along with a special 6 percent credit for qualified small businesses (defined as gross income less than $100 million). The state also offers a credit of 20 percent on the increment in qualified research expenditures over the base year, again per federal definitions. For small businesses (defined as grossing less than $70 million), the state will refund in cash 65 percent of the value of R&D credits that cannot be used for lack of tax liability, in lieu of a carryforward option. The program is as of right, i.e., the firm automatically receives the credit if it qualifies. In some states the credit is discretionary.

New York State offers another as-of-right refundable program, although it is more complex and almost completely decoupled from the federal definitions for the R&D tax credit. The credit targets Qualified Emerging Technology Companies (QETC), which must (1) operate in one of several statutorily defined bio/high-technology sectors or have a ratio of R&D to sales of at least 6 percent; (2) have fewer than 100 full-time employees, 75 percent of whom are employed in NYS; and (3) have gross revenues less than $20 million. In addition to credits to investors for investment in QETC *and* for employment by QETC, the act offers a fully refundable 9 percent credit for "Facilities, Operations and Training," a set of activities that embraces traditional qualified research expenditures but critically *also* includes the *soft* costs associated with patenting and commercialization; a training credit of $4,000 per employee; and an R&D property credit of 18 percent. QETC can take these credits in any combination and apply for a refund up to $250,000 per year for 4 years. This is viewed very concretely as a way for the state to inject early-stage resources into bio/high-technology companies.

Although the program is capped, and discretionary rather than as of right, the **New Jersey** Economic Development Authority is authorized to certify annually up to $60 million (recently increased from $40 million) in both net operating loss and unused R&D tax credits for sale by bio/high-tech companies that cannot use them because of lack of tax liability to companies that can, for at least 75 percent of their value. Of this amount, $10 million is set aside for approval in the "Innovation Zones" defined around the state's principal research universities. Applicants must have fewer than 225 employees including the parent and all subs. The intent is for sellers to use certification and sale in order to fund "growth and operations, either as working capital or to fund research." The process is therefore seen as a discretionary economic-development program, and it is complex enough that there is apparently a market need for a commercial broker to match buyers and sellers under extensive rules set by the Authority. The underlying R&D tax credit is not especially unusual or noteworthy.

Proposed Activities: The LSAB recognizes the importance of Maryland's R&D tax credit program to innovation in the state and proposes the following changes:

- Eliminate the sunset provision and allow the R&D credit to become a permanent feature of Maryland's tax code, thus allowing companies to plan and project more reliably.
- Raise the cap by $3 million for both basic and growth credits and target these additional amounts to bioscience companies with 50 or fewer employees, consistent with the state's decision to prioritize development of the bioscience industry.
- Make Maryland's R&D tax credit refundable to bioscience companies with 50 or fewer employees up to the first $1.5 million in eligible credits, reflecting the reality that few small bioscience companies are profitable and many, even with highly productive R&D programs, are struggling to survive to the point of commercialization.
- Raise the cap on the overall R&D tax credit over time to raise the effective level of the credit to achieve and maintain the statutorily intended benefit to participating companies.

Resources Required:

It is proposed that the overall cap be increased by $6 million to $12 million, with $3 million targeted to bioscience companies with 50 or fewer employees. A goal of $24 million is proposed by 2020 representing a fully funded 3 percent investment tax credit for bioscience companies in 2008 dollars.

Performance Measures:

- Increase in R&D expenditures by Maryland bioscience companies
- Increase in the total number of bioscience companies participating in the program
- Increase in the overall credits received per company
- Job growth and other business success metrics of companies receiving R&D credits

Lead Organization(s):

DBED administers the Maryland R&D Tax Credit Program.

Action Seven: Establish the Maryland Life Sciences Venture Capital Trust to advance investment in Maryland bioscience companies by pension and venture funds

Rationale: For Maryland's bioscience industry to grow at a globally competitive pace, venture capital investment in the state's bioscience enterprises must also keep pace. While Maryland's bioscience venture activity has generally risen over the past decade, recent venture activity has fallen off, and there is a concern that local venture capital firms are more focused on bioscience ventures outside the state. Public pension fund investment in bioscience ventures can send a powerful signal of a state's commitment to advancing its bioscience industry and make available an important source of venture capital.

For many years, many American state pension funds were constrained to invest only in vehicles on a statutory or "legal list" of permissible investments: if a given state permitted venture capital, a percentage of asset allocation was often specified, sometimes along with "dual test" criteria for economic benefit; if venture capital was not explicitly permitted, it was off the table. As states began to move their pension funds toward modern "prudent person" or "prudent expert" standards of investment, many more state pension funds were able to move into venture capital. However, these investments must be at a level consistent with the long-term planning horizon and risk tolerance of the state pension fund, and potential reward must be commensurate with risk taken.

Maryland itself has experience attracting out-of-state venture managers through its creation in 1990 of the Maryland Venture Capital Trust, a "fund of funds" that channeled nearly $20 million in appropriations and investments from state and city pension funds into a series of eight venture partnerships that agreed to open active local offices. The Trust was created under law as a public instrumentality governed by seven trustees appointed by the Governor on advice and consent of the state Senate and required to have certain skills and to represent at least in part the "participating investors."[9] The Trust was empowered to solicit participating investments from any source "including not more than $2 million in appropriations" and limited to no more than $15 million from the state retirement and pension system (which was not legally required to invest). In the end, it achieved a pool of $19.1 million composed of the following:

- The $2 million appropriation
- $15 million from the Maryland State Retirement and Pension System
- $840,000 from the Employees Retirement System of the City of Baltimore
- $1.26 million from the Fire and Police Employees Retirement System of the City of Baltimore.

Notably, the Trust was given the power to negotiate terms with its investee venture funds and was charged to prefer investing in venture funds that

[9] See Maryland Code Article 83A, Sections 5-301 through 5-309, available online at http://www.michie.com/maryland/lpext.dll?f=templates&fn=main-h.htm&cp=mdcode.

- "Conduct a substantial amount of business in the state"
- "Match the money invested by the Trust with money invested by private investors in at least a 1:3 ratio"
- "Ensure that a majority of the money invested by the Trust be for seed-capital financing in Maryland."

The first two preferences were enforced through issuance of requests for proposals (RFPs) and the latter through informal side agreements with the investee funds that they would invest in seed-stage Maryland companies at least the amount invested in them by the Trust. It took 2 years to select eight venture-capital partnerships. The Maryland Venture Capital Trust generated a return of 10 percent and ended up generating $327 million in venture capital under management, a 1:17 ratio for investments by the Trust.

Three of the leading states in public pension fund investment are California, Massachusetts, and Pennsylvania, all of whom are also key peer states for Maryland. For Massachusetts, several public pension funds including the main state fund, the Public Employee Retirement Administration Commission (PERAC); the Boston City Retirement Board; and the Massachusetts Bay Transportation Authority Retirement Fund all hold substantial private-equity or other alternative investments. The Pennsylvania State Employees Retirement Fund and the Public School Employees Retirement Fund both have a long history of investing in venture-capital partnerships domiciled in state as a strategy for both financial return and economic impact. In California, the two largest California public pension funds—the California Public Employees' Retirement System (CalPERS) serving public employees and the California State Teachers' Retirement System (CalSTRS) serving the state's teachers—both make significant investments in private equity, as do several of the larger city and county programs and the separately managed pension system of the University of California. The CalPERS California Initiative,[10] established in 2001, represents a commitment to invest a portion of its private-equity allocation through 10 fund managers "in traditionally underserved markets, primarily, but not exclusively located in California." As of September 30, 2007, Phase I of the initiative had invested $375 million of a targeted $475 million at an investment return ratio (IRR) of 18.2 percent.

Currently, the State Retirement and Pension System of Maryland reports that it makes a 1 percent allocation to private equity ($386 million), trending toward a 2 percent board-approved target. Based on the success of the System's investment in Maryland Venture Capital Trust, the LSAB believes that it may be possible to create a similar fund-of-funds approach, focused on investments in the biosciences, which would be attractive to the System as a potential additional allocation of investment to private equity—and would also attract increased investment of venture capital and help achieve Maryland's broader objective of supporting the continued growth of the strategically important bioscience industry in the state.

Proposed Activities: The LSAB proposes that the Maryland Life Sciences Venture Capital Trust be established to (1) offer an attractive vehicle for private-equity investment in life science companies by the Maryland State Retirement and Pension System; and (2) attract additional private-equity investment in Maryland life sciences from venture capital funds both within and outside the state, while also offering the realistic expectation of a competitive rate of return on investment with an investment profile consistent with modern "prudent person" or "prudent expert" standards of investment. The Maryland State Retirement and Pension System would not be required by law to invest in the new fund of funds, but the System's Board of Trustees would be asked to consider investing in the Maryland Life Sciences Venture Capital Trust as part of its allocation to private-equity investment. Specifically, LSAB proposes the following:

- The **Maryland Life Sciences Venture Capital Trust** would be established with an initial $10 million seed investment from the State of Maryland as a fund of funds focused on seed, early-stage, mid-stage, and late-stage private-equity investment in life science companies (see third bullet, below); up to $250,000 of this amount would be dedicated to a comprehensive assessment and creation of an implementation plan for the following proposal for implementation of this LSAB recommendation—**to be conducted by DBED in cooperation with the Maryland State Retirement and Pension System**, to ensure that

[10] See http://www.calpers.ca.gov/index.jsp?bc=/about/press/news/invest-corp/home.xml.

it is consistent with best practices and offers a realistic expectation of a competitive rate of return on investment with an investment profile consistent with modern "prudent person" or "prudent expert" requirements.

- **The Trust would be created under law as a public instrumentality governed by an appropriate number of trustees to be appointed by the Governor on advice and consent of the General Assembly;** these trustees would be required to have appropriate experience and skills, to represent the interests of participants in the Trust, and to commit on a "best efforts" basis to work toward achieving the state's other objectives, as described below.

- **The Trust would be empowered to solicit participating investments from any source** and would include an initial $10 million from the state as a seed investment (as mentioned in the first bullet, above). The Trust would seek investment from the state retirement and pension systems (with both the decision regarding whether to invest, as well as the amount of any investment left entirely to the discretion of fund trustees) and with a goal of aggregating at least $100 million in total funds for investment by the Trust in venture funds focused on early-stage, mid-stage, and late-stage private-equity investment in life science companies.

- The Trust would be given the power to negotiate terms with investee venture-capital funds and charged with the following objectives:
  - Invest in venture funds focused on early-stage, mid-stage, and late-stage private-equity investment in life science companies, which agree to match the money invested by the Trust with money invested by private investors in at least a 1:3 ratio.
  - Ensure that a majority of Trust investments are directed to early-stage, mid-stage, and late-stage private-equity investment in life science companies in Maryland.
  - Invest preferentially in funds that have or will commit to establish offices or have or will commit substantial funds to early-stage, mid-stage, and late-stage private-equity investment in life science companies in Maryland.

Utah Fund of Funds

A different approach that manages the fund of funds in the private, nonprofit sector is the Utah Fund of Funds. Backed by $300 million in refundable, transferrable tax credits, the Utah Capital Investment Board (a state agency) guarantees institutional fixed-income investments (currently the sole investor is Deutsche Bank) in a pool of funds that is then managed as a fund of funds by the Utah Capital Investment Corporation (a state-charted private nonprofit) under the overall advice of Fort Washington Capital Advisors of Cincinnati (which was selected in a competitive RFP). The fund of funds is allocated to venture-capital partnerships with these characteristics, enforced by the corporation: (1) funds that have a successful track record or managers with a successful track record; (2) funds that invest in companies in industries in which Utah consistently has high-quality investments available; and (3) funds that have shown or commit to show interest in investing in Utah. Fund I began operations in 2006 and had made 20 commitments as of February 2008 based on applications by 170 managers. Of the 20 funds selected, seven mention life sciences or health care as one of their targets, though only one of those targets seed or early stage. Of 359 investments reviewed by the selected venture-capital funds as of that date, 25 investments had been made totaling $127 million, leveraging $365 million in other capital and creating more than 1,000 jobs at an average annual salary of $60,000. Perhaps most significantly to the state's public-policy goals, partners at the investee venture funds had spent a cumulative total of 290 days in Utah, and Fort Washington opened a Utah office.

Resources Required:

It is proposed that the state invest $10 million to seed the Maryland Life Sciences Venture Capital Trust. It is proposed that an additional $100 million be raised from the state and other pension funds, matched 3:1 by private funds.

Performance Measures:

- Achieving the Trust target of at least $100 million in total funds for investment by the Trust
- IRR achieved by Trust for the Maryland State Retirement and Pension System and other participating investors
- Funds invested in Maryland bioscience companies
- Jobs created by bioscience companies invested in

Lead Organization(s):

The Fund would be administered by a newly created organization, the Maryland Life Sciences Venture Capital Trust. DBED, working in cooperation with the Maryland State Retirement and Pension System, would design the Trust and develop an implementation plan.

Action Eight: Ensure the availability of product development capital for emerging bioscience companies

Rationale: Few sources of funds are available to entrepreneurs and emerging bioscience companies as they move through the product development process. In recent years, venture funds have trended toward later-stage investments. Angel investors focus primarily on seed and early-stage investments, enabling initial steps in product development. Thus, firms have been facing an increasingly large funding gap in the mid-phases of the product development cycle, often causing development to stall or fail altogether.

The Maryland Venture Fund is the principal state program helping technology-based companies advance from seed stage through initial product development. The Fund's Challenge Investment Program provides seed funding in the form of convertible debt to companies in the range of $50,000 to $100,000. In addition, for technology-based companies pursuing venture capital financing, Maryland's Enterprise Investment Fund offers equity financing of $150,000 to $500,000, with a 3:1 match required from private sources. Unfortunately, the total dollars allocated to the Maryland Venture Fund has declined from $9 million in FY 2001 to $2 million in FY 2009.

In contrast, other states are stepping up their investment, with more than 20 states having established public venture programs. Ohio's Third Frontier Program is investing $263 million in its Pre-seed Fund Initiative, which is supporting the development of regional seed funds throughout the state. Michigan allocated $109 million for early-stage financing in 2008 through its 21st Century Fund.

Proposed Activities: The LSAB believes that it is important to ensure adequate availability of capital to support early-stage life science companies as they move from seed stage through initial product development in their progress toward commercialization. The LSAB proposes that the following specific steps be taken:

- **Increase the appropriation to the Maryland Venture Fund** to ensure that the state can provide seed financing and matching investment in first rounds of equity financing. The LSAB recommends restoring—over time—the ability of the Fund to help address this challenge, beginning by restoring the Fund as quickly as feasible to the $9 million level last seen in FY 2001 and then inceasing funding in increments to $24 million by 2020.
- **Establish the Maryland Bioscience Product Development Loan Fund to address the gap in Maryland support**—to be administered by the MBC. Not all successful bioscience companies will follow the path of venture capital funding. Sources of patient working capital are severely limited in Maryland for qualified bioscience companies moving a product beyond proof-of-concept through the later steps involved in getting a product ready for market introduction. Financing is needed to finalize product development, address regulatory questions, and begin the scale-up of production. It is proposed that the Maryland Bioscience Product Development Loan Fund be established within the MBC to

provide a long-term working capital loan of up to $500,000 to a qualified bioscience company in the later stages of product development and market introduction. The terms for this loan would be structured in a way similar to the approach used by the North Carolina Biotechnology Center:

- Five-year balloon
- 1 percent above prime rate
- Unsecured
- Company warrants equivalent to 25 percent of the loan principal amount
- Execution of a Financial Assistance Agreement that calls for active monitoring of project progress and contract compliance until the financial assistance is repaid in full. Periodic progress reports and occasional site visits may be required.

Resources Required:

The LSAB recommends (1) that funding of the Maryland Venture Fund be restored as quickly as feasible to the $9 million level last seen in FY 2001 and then inceased in increments to $24 million by 2020 and (2) that the Bioscience Product Development Loan Fund be funded and maintained at a level of $5 million.

Performance Measures:

- Firms assisted
- Leveraged funds
- Jobs created
- New products introduced and sales generated

Lead Organization(s):

The Maryland Venture Fund will continue to be operated by DBED. The Maryland Bioscience Product Development Loan Fund will be implemented by the MBC.

Strategic Priority Three: Position Maryland for global leadership in cutting-edge areas of bioscience research and emerging growth markets

Action Nine: Strengthen technology transfer at research universities and the ability to launch bioscience ventures based on university research

Rationale: Although Maryland is a global leader in bioscience discovery and innovation, a significant gap exists between the initial discovery and its translation into a product that can benefit a patient or customer and ultimately achieve commercialization in the marketplace. This problem is not unique to Maryland, as the Food and Drug Administration (FDA) has noted: "At a time when basic biomedical knowledge is increasing exponentially, the gap between bench discovery and bedside application appears to be expanding. There is a great concern about the ability to bring the hoped-for outcomes of basic medical research advances—much awaited new treatments—to patients. There is concern that hoped-for advances in medicine and new treatments for diseases may not happen." [11]

There is a significant need for state-level intervention to support technology transfer and the creation of new bioscience ventures from basic research discoveries. The federal government funds primarily the research enterprise but not the technology transfer infrastructure. Too often, universities and other nonprofits focus on receiving funds available from the federal government and corporate sponsors for their research, while companies (start-up and established) focus on receiving funding from venture capitalists and internal sponsors for commercial-ready technologies. This situation creates little or no incentive for either the research institution or industry to move basic research into commercialized products.

For the biosciences, the "valley of death" is a much longer and expensive process than for other technology areas, particularly information technology. This is partly due to the highly regulated nature of bioscience innovation in which any new therapeutic or medical device must go through a rigorous and expensive clinical trials process.

Maryland has put programs in place to advance technology commercialization, but they focus primarily on the initial steps in the commercialization pathway and are not well funded. One such effort is the TEDCO University Technology Development Fund (UTDF), which supports precommercial research on university intellectual property to increase the likely success of developing a product that can be brought to market successfully. In addition, the TEDCO Maryland Technology Transfer Fund (MTTF) provides up to $75,000 in a nonequity investment to fund companies that wish to develop products or services in collaboration with universities and federal laboratories. Another potential source of such funding is the Maryland Industrial Partnership Program (see Action 10).

The University System of Maryland (USM) technology transfer operations are also underfunded. Today, Maryland universities rank

Georgia's VentureLab Program

In 2002, the Georgia Research Alliance (GRA) created a statewide VentureLab program modeled on a successful Georgia Tech Program. VentureLab identifies university technology, evaluates its commercial value, and awards grants to fund additional development work for those judged to have commercial potential. Commercialization grants are awarded in three Phases:

- Phase I grants of up to $50,000 to validate the technology
- Phase II grants of up to $100,000 for prototype creation
- Phase III grants of up to $250,000 to complete a business plan and launch the company.

An integral component of the program are Venture Fellows, experienced start-up business professionals who act as advisors to university scientists and engineers interested in starting a company based on their research. The Venture Fellows advise a number of companies eventually joining one as a member of the senior management team.

Since 2002, VentureLab has led to the formation of more than 70 early-stage companies that employ 450 investments.

[11] Food and Drug Administration. *Innovation Stagnation: Challenge and Opportunity on the Critical Path to New Medical Products*. U.S. Department of Health and Human Services, March 2004.

in the middle of the pack in levels of disclosures, patents, and new start-ups. What is not understood is that the state's universities are being asked to handle their technology transfer mission with considerably fewer appropriately qualified staff and less funding to support and advance patent applications than comparable institutions in other states. To be specific, the USM has 16 people in its technology transfer offices, compared with 30 to 32 at comparable institutions in other states, and spends $1.8 million annually on patent protection, compared with an average of approximately $6 million at comparable institutions. USM technology transfer operations do well with what they have, but it is not enough.

Proposed Activities: The LSAB recommends that Maryland continue to advance efforts to strengthen university technology transfer and the ability to create bioscience ventures from university research, including the following steps:

- **Increase funding for technology transfer and proof-of-concept development funding by TEDCO to $5 million per year**—expanding the resources available through both the UTDF and the MTTF. Allow these programs to grow over time and increase funding in accordance with demand and opportunity.
- **Increase funding for scientifically and commercially skilled technology transfer personnel and for patent expenses and monitoring in the USM to a level consistent with funding levels at comparable universities nationwide**. This would require $1.5 million for personnel and $2 million for patent funding/monitoring.
- **Conduct a comprehensive review of internal and extramural policies and procedures that affect the university–private-sector collaboration** for the development and commercialization of technology discovered at Maryland's state universities. An independent review of technology transfer and R&D collaboration policies and procedures, and their impact on university–private-company relationships, is recommended to identify issues that limit the number and scope of collaborations in Maryland. The goal of this study is to identify barriers and recommend best practices that will support the mission of the universities, enable success of small and large bioscience companies, and bring economic rewards to the state. An estimated $200,000 would be required for the study.

Resources Required:

Costs are proposed as follows: $5 million annually to support the UTDF and MTTF programs; $3.5 million annually to augment technology transfer activities at the USM; and a one-time cost of $200,000 for a study of university technology transfer practices.

Performance Measures:

- Inventions disclosed
- Number of patents generated
- Number of licenses granted
- Prototypes created and proof-of-principle demonstrated
- New products (investigational new drug [IND] applications, clinical trials, regulatory approvals, etc.)
- Start-up companies launched within and outside Maryland with university technologies

Lead Organization(s):

The MTTF and UTDF will continue to be administered by TEDCO. The USM will administer the technology transfer program. The MBC will oversee the implementation of bioscience venture fellows and commission the study of university technology transfer practices.

Action Ten: Establish Bioscience Commercialization Institutes in Maryland

Rationale: Basic scientific discovery lies at the heart of every commercial innovation in the life sciences. But, the conversion of basic scientific discovery into tangible application—in the clinic, the home, the workplace, or the laboratory—represents a limiting step that often leaves unharvested opportunities to die on the vine.

There is a formidable gap between the discovery of a key molecule, disease marker, or biological mechanism and the development of an agent or test that has been sufficiently validated to permit experimental use in humans or in the field. At one side of the gap lie academic institutions. These are generally unable to conduct the work required to bring this about—which in the case of a therapeutic agent would involve assay development, validation, primary screening, compound modification, secondary screening, safety testing, production, and satisfaction of regulatory demands. These processes lie beyond the capabilities of most academic laboratories and would divert those laboratories from their fundamental mission, which is to provide the basic discoveries on which applications themselves are based. On the other side of the gap lie the biotechnology and pharmaceutical sectors, which are increasingly reluctant to consider commercialization of an academic research product until it is ready for later-stage clinical testing.

The Harvard Laboratory for Drug Discovery in Neurodegeneration (LDDN)

The Harvard Laboratory for Drug Discovery in Neurodegeneration (LDDN) was launched in mid-2001 with $37.5 million from an anonymous donor to further research on neurodegenerative diseases with an initial focus on Alzheimer's disease. The unique goal for this unit is the creation of a new model for drug discovery that integrates the best of industry and academia, thereby translating basic research findings into drugs to treat the many diseases in which the pharmaceutical industry is unable to invest because of revenue/profit pressures. The basic research and operational focus for LDDN is the discovery of chemical entities that can be used as lead structures in the development of drugs for neurodegenerative diseases. On the academic side, the LDDN has access to tremendous resources in the Boston/Cambridge community and can leverage its own administrative staff with academic researchers for focused discovery efforts.

In addition to assay development, high-throughput screening, and informatics, LDDN is one of the few academic units to offer

Maryland is one of the world's most concentrated centers of research in the life sciences. Despite its extraordinary productivity, Maryland has not achieved the cachet of the San Francisco Bay Area, San Diego-La Jolla, or the Massachusetts Route 128 Corridor with respect to commercialization of discovery. Maryland's plentiful research productivity has been underexploited by commercial interests. In this unique setting of hunger in the midst of plenty, it would be inadequate to merely mimic approaches that have been tested in less research-intensive settings.

This gap between research discoveries and developing innovative new products is not only found in the biosciences, but is a well-recognized "valley of death" in technology commercialization. For the biosciences, there is a need to have in place a systematic applied research capacity and approach to advance new drug and device development coming out of research discoveries in its university or federal research labs.

For instance, in therapeutics development, a wide range of institutions from Harvard to Duke to St. Jude Children's Hospital are developing specialized efforts for drug discovery and development including assay development, high-throughput compound screening, informatics, medicinal chemistry, preclinical testing, and regulatory expertise required for advancing drug discovery and development.

Similar efforts are going forward to advance biomedical devices, such as the Alfred Mann Institute at the University of Southern California (USC), which provides dedicated and specialized prototype development space on the USC campus for Good Manufacturing Practice (GMP) certified clean room facilities, electronics and machine shops, and systems validation and software development facilities as well as commercialization services involving intellectual property development and patent protection, market analysis, regulatory guidance, and licensing support.

The only state-level initiative of a similar type is taking place in Oregon through the newly funded Oregon Translational Research and Drug Development Institute (OTRADI), which is a multi-institutional collaboration involving more than 70 researchers from the Portland State University, the University of Oregon, Oregon State University, Oregon Health and Science University, and several Oregon-based

biotechnology companies to provide screening and optimization of new chemical entities and validate targets for advancing innovative therapies for infectious diseases. Colorado is proposing a similar effort as part of its recent bioscience strategy.

The formation of multi-institutional bioscience research projects and centers can be significantly informed by the core competency analysis of Maryland's industry, universities, and federal research labs in the biosciences. States are learning that the research enterprise must nurture the development of specialized areas of expertise, or core competencies, in which they can be national or global leaders. From a state perspective, core competencies across the research enterprise are those focused areas where the state's research base can bring a critical mass of activity—as measured by research, talent generation, and unique facilities and resources—along with an identified measure of excellence.

In Maryland, only fledgling efforts are underway including the new Fraunhofer Institute at JHU for noninterventional medicine and the Maryland Drug Discovery and Development Network; but, these efforts lack the intensive services, facilities, and scale to have significant impact. It is therefore proposed that Maryland pursue a direct approach to the conversion of basic discoveries into products that improve the health and well-being of people in Maryland and throughout the world. Through this novel, aggressive approach, the state would become an active partner in the process that bridges the gap between the academic laboratory and the commercial sector.

Proposed Activities: The LSAB recommends that Maryland advance a comprehensive initiative for bioscience technology commercialization involving the formation of new Maryland Bioscience Commercialization Institutes. These Bioscience Commercialization Institutes are needed to provide the translational R&D infrastructure to accelerate and retain commercialization activity in Maryland and would target the technology platform areas identified in the core competency study.

The Institutes would be organized, funded, and implemented over time through the MBC through a competitive RFP process. It is critical that these Bioscience Commercialization Institutes represent multi-institutional collaborations that involve industry participation in order to have the scale and path to market to be successful.

The Maryland Bioscience Commercialization Institutes could be implemented in phased fashion but would ultimately encompass laboratory facilities and research staff, accessible to academic and commercial clients, thus constituting a bridge between academic and commercial partners. The Maryland Bioscience Commercialization Institutes would enter into joint development agreements with Maryland universitities and federal research institutions to advance promising discoveries that meet rigorous market assessment and due diligence tests. At the same time, the Institutes would consider partnerships with private companies or private-sector initiatives. The services available under the Institute would either be contracted from available resources in Maryland or would be developed and managed by the Institute, either directly or through partnerships.

Each Institute formed should concentrate its expertise, such as in small molecule therapeutics, biological therapeutics, device development, or diagnostics, as the technologies required for development in each of these areas differ somewhat. Given Maryland's strong technology platform in biopharmaceuticals, the LSAB recommends that the first Maryland Bioscience Commercialization Institute be formed for drug discovery and development. This drug discovery and development commercialization institute should provide or contract for capabilities in assay development, high-throughput compound screening, informatics, medicinal chemistry, preclinical testing, and regulatory expertise required for advancing drug discovery and development based on discoveries made in the state's universities, both public and private, as well as federal laboratories.

Similar Maryland Commercialization Institutes would later be considered to advance the commercialization of diagnostics and medical devices, or focused around specific technologies, such as imaging, nanobiotechnology for drug delivery, or environmental/industrial biotechnology for biofuels or remediation.

Resources Required:

It is recommended that Maryland target up to $100 million by 2020 to establish and fund four Bioscience Commercialization Institutes to accelerate and retain bioscience commercialization activity in Maryland. Each Institute would be funded at up to $5 million per year with matching fund requirements for specific projects and programs undertaken.

Performance Measures:

- New products (IND applications, clinical trials initiated, drug and devise regulatory filings and approvals, etc.)
- Start-up companies launched

Lead Organization(s):

The MBC will oversee the implementation of the Maryland Bioscience Commercialization Institutes.

Action Eleven: Expand the Maryland Industrial Partnership Program (MIPS)

Rationale: The LSAB believes that Maryland needs to scale up its efforts to support the advancement of university-industry partnerships.

Maryland has one program initiative, the Maryland Industrial Partnership Program (MIPS), with a proven track record of working with industry to accelerate the commercialization of technology by funding collaborative university-industry product R&D projects. Originally started as an outreach effort by the UMCP Engineering School, MIPS has grown to encompass all campuses of the UMS across all fields. MIPS projects are conducted by university faculty and graduate students in conjunction with company researchers. With more than 800 project awards worth over $140 million since 1987, MIPS projects have generated solid results. MIPS-supported products have generated more than $14.4 billion in sales, added jobs to Maryland, and exported state-of-the-art Maryland-originated technology into the global marketplace.

Approximately two out of three companies funded by MIPS are start-ups, which are defined as being less than 4 years old, with under $1 million in revenues and fewer than 12 employees. Historically, approximately 40 percent of the companies assisted by MIPS have been bioscience companies; but, biorelated applications have risen to 57 percent in the past 2 years. Despite the fact that funding for MIPS was recently increased from $1.35 million to $2.05 million, funding this past year was available to support only 44 of the 78 fundable projects; thus, approximately 44 percent of fundable projects for MIPS were not funded. Fifteen of these were bioscience companies.

GRA Technology Partnerships Program

Similar to MIPS, the Georgia Research Alliance funds university-industry partnership grants up to $100,000 a year for 3 years, matched 1:1 by in-state companies. One important aspect of the program is that Technology Partnership awards often are used to assist firms that participate in other GRA initiatives. For example, the company may be a tenant of one of the GRA-supported business incubators; it may have emerged from a laboratory of a GRA-funded eminent scholar or from a GRA-funded major research facility; it may have benefited from special funding offered to encourage two eminent scholars to collaborate with each other; and most importantly, it may also have been created through the activity of **VentureLab**, a grant that provides universities up to $50,000 for due-diligence on early-stage commercialization concepts and up to $100,000 for prototyping and business planning.

Moreover, MIPS does not extend to the JHU, which is a major omission in leveraging university-industry partnerships for the benefit of Maryland's private-sector growth, as well as other Maryland postsecondary institutions, such as the state's network of community colleges. In the mid-1990s, there was an "extended MIPS" initiative that reached out to JHU, but that lasted only a short while.

Proposed Activities: The LSAB proposes that the MIPS Program be expanded in the following manner:

- **Expand MIPS to include JHU and all other public or private institutions**, reflecting the underlying intent of the program, which is to promote university-industry product R&D partnerships throughout Maryland, rather than through the USM alone.
- **Recognize the higher cost of bioscience projects by funding them up to $100,000 per qualified fundable project**, regardless of company size. (The current MIPS limit is $100,000 for all companies except start-up companies, defined as those with 12 or fewer employees, which are currently limited to $90,000.)
- **Increase overall MIPS funding by $3.95 million to $6.0 million**, with the requirement that approximately 60 percent of total funding be allocated to bioscience projects, up from approximately 40 percent in the past year.

Resources Required:

A total of $6 million annually is recommended to fund the MIPS Program; 60 percent of this funding would be targeted to bioscience projects.

Performance Measures:

- Number of bio-related project applications and awards versus total
- Matching funds
- Key business milestones achieved (e.g., products developed, products introduced to market, sales generated, etc.)
- Jobs created
- Cost per job created

Lead Organization(s):

University of Maryland and JHU will work together jointly to administer the expanded MIPS Program targeted to the biosciences in a manner consistent with the basic design of the existing program. The MBC will oversee the development of this expanded MIPS Program targeted to the biosciences.

Action Twelve: Promote investment in emerging fields of bioscience research

Rationale: New fields of bioscience research continue to emerge that can reshape the playing field, create new opportunities to benefit humankind, and lead to commercializable technologies and products, as well as the creation of new companies and job growth in Maryland. Stem cell research, nanobiotechnology, epigenetics, personalized medicine, and agbio are just a few of many examples. Making investments to ensure that Maryland is a leader in strategically important emerging fields of bioscience research is critically important to Maryland's long-term competitive position.

The Maryland Stem Cell Research Fund was created in 2006 to provide funding in support of stem cell R&D of potential new therapies, through grants and loans to public and private entities within the state. To date, under the guidance of the Maryland Stem Cell Research Commission and under the administration of TEDCO, more than $36 million has been awarded in response to 86 research applications. Now in its third year, the Maryland fund is the third-largest state stem cell research fund in the United States and the only one besides New Jersey's that expends 100 percent of its committed or appropriated funds each year.

Maryland is also one of the leading research centers in the United States for nanotechnology and, in particular, nanobiotechnology. In its third year, administered by DBED, the Maryland Nano/Biotechnology Initiative has received $7.3 million in state funding over the past 3 years.

The LSAB believes that increased funding to both of these programs, and the flexibility to identify and fund future priority bioscience research initiatives, is important to growing and maintaining a position of leadership for Maryland in these emerging fields of research. The core competency study prepared by Battelle identified several other emerging competency areas in Maryland that are likely candidates for future funding, such as epigenetics, synthetic biology, and systems biology. These emerging areas of focus should be developed in close consultation with the federal labs in Maryland to ensure that they promote Maryland's overall bioscience cluster development.

The LSAB also believes that no strategic approach currently exists in Maryland for the systematic identification and consideration of newly emerging fields of bioscience research that may merit the state's support. Standard operating procedures do exist for screening and selecting projects submitted to agencies for funding, but the focus of such efforts is necessarily programmatic. Although it seems clear that the current programs in support of stem cell research and nanobiotechnology are worthy of support from public funds, the lack of a strategic approach to investment in new fields of research makes it more difficult to achieve leadership at the early stages of a field's emergence.

Proposed Activities: The LSAB proposes the following:

- Establish the LSAB Bioscience Research Initiatives Review Committee with minimal funding, to work with the LSAB and the MBC to provide ongoing consideration of newly emergent fields of bioscience research and to make recommendations to the LSAB regarding potential support. The LSAB would then consider these recommendations in the broad context of its role in guiding the MBC and advising the Governor's office and the Maryland General Assembly of actions and programs that may be important to the future development of the bioscience industry in Maryland. The members of the LSAB Bioscience Research Initiatives panel would include five to seven distinguished scientists representing a range of academic institutions, federal laboratories, and the private sector. The LSAB proposes that $50,000 be allocated to this effort within the MBC to support coordination of meetings and communications, distribution of materials, etc.
- Increase funding for the Maryland Stem Cell Research Fund from $19 million to $20 million.
- Increase funding for the Maryland Nanobiotechnology Initiative from $2.4 million to $5 million.

Resources Required:

Annual funding of $20 million is recommended for the Stem Cell Initiative and $5 million for the Nanobiotechnology Initiative through FY 2020—which ensures the continuity and sustained effort needed to propel Maryland forward. Additional annual funding of $50,000 is recommended to support the LSAB Bioscience Research Initiatives Review Committee. Future recommendations for funding to support emerging fields of bioscience research would be developed by the Committee.

Performance Measures:

- Number of institutions involved
- Leverage of new R&D funding in the targeted technology area
- Publications generated in peer-reviewed journals
- Inventions disclosed
- Patents issued
- Number of spin-out companies developed from research
- Number and value of licenses generated
- New products introduced

- Sponsored research

Lead Organization(s):

MBC, TEDCO

Action Thirteen: Establish the Maryland Federal Lab Engagement and Collaborative R&D Program

Rationale: Maryland has one of the largest concentrations of federal institutions and agencies that conduct R&D in the life sciences and related fields, such as biomedical engineering, bioinformatics, and nanobiotechnology, among others. Maryland is well-positioned to address federal needs; capture federal solicitations and procurement opportunities; and lead the nation in the creation of model programs that link federal laboratories, universities, and industry.

However, for the most part, Maryland's research universities and federal labs work within their own institutional walls. While there may be considerable interdisciplinary research taking place within individual institutions, there is little multi-institutional collaboration. By comparison, it is commonplace for major research centers to address major and emerging scientific fields across the University of California System and in major regional centers of research such as Boston. Even states such as Ohio and Arizona are actively promoting multi-institutional collaborations, and the State of Texas has an emerging multi-institutional lab initiative.

There are some bright spots in Maryland that suggest that a focused effort to promote collaborations can bear fruit, including the following:

Global Cardiovascular Innovation Center

The Global Cardiovascular Innovation Center (GCIC) is one of five Wright Centers of Innovation supported by Ohio's Third Frontier Initiative, a $1.6 billion, 10-year initiative aimed at accelerating the growth of Ohio's economy through globally competitive research and innovation. GCIC is the only one of the Centers considered a Wright Mega Center of Innovation, meaning that the level of support provided to the Center is significantly higher than that provided to the initial four Centers. All of the Centers are required to be multi-institutional collaborations involving Ohio universities, health care institutions, other nonprofit research organizations, and large and small Ohio companies. The Mega Centers are defined as centers of excellence that will clearly define Ohio as an international leader for research and commercialization for one or more technology platforms that will have a substantial, measurable, and sustainable impact on the state's economy.

GCIC is a $250 million product commercialization consortium led by the Cleveland Clinic. Partners include Case Western Reserve University, The Ohio State University, the University of Cincinnati, the University of Toledo, University Hospitals, industry leaders, and economic development organizations. The State of Ohio contributed $60 million to the Center.

GCIC provides commercialization assistance to its member companies, including creation of spin-off companies and equity partnerships, assistance with licensing and IP issues, technology validation and links to venture capital funding networks and access to prototyping and preclinical facilities. GCIC currently has 12 companies in its portfolio. GCIC has an Entrepreneurs-in-Residence program and has organized a venture investment consortium that includes professionals from several prominent venture-capital firms who will jointly evaluate investment opportunities. Talent recruitment services are available through Case Western Reserve University.

- The Center for Advanced Research in Biotechnology, which is a partnership of University of Maryland Biotechnology Institute (UMBI) and the National Institutes of Standards and Technology (NIST) and is advancing the measurement, analysis, and design of biomolecules—a field known as structural biology.
- UMCP's collaborations with the U.S. Department of Agriculture's Beltsville Research Lab, focusing on areas ranging from turf grass evaluation to plant molecular pathology, with planned collaborations in plant-based bioproducts and systematics.
- Growing collaborations in bioengineering, with a new graduate program that includes faculty from UMB, UMCP, UMBI, FDA, and NIH.

Proposed Activities: The LSAB recommends that Maryland promote and foster the development of federal lab/university/industry collaborations through a dedicated fund to perform the following

- Support a Web-based inventory to enable shared use of specialized research facilities and equipment
- Foster partnerships through seed funding to advance joint centers, shared-use infrastructure, CRADAs, and pilot research projects
- Support strategic faculty hires
- Develop joint federal lab–university graduate programs
- Promote clinical research partnerships between federal labs and academic health centers and other hospital settings
- Encourage outreach to industry for multi-institutional research projects and centers.

It is expected that Maryland will have many opportunities for multi-institutional collaborations that involve industry participation, and it is recommended that a competitive RFP process would be implemented by the fund. The RFP process for collaborative multi-university initiatives would focus on the following:

1) Assessment of the availability of federal R&D funding in the proposed research collaboration area. A key mechanism to foster strategic collaborations across universities will be the availability of additional federal funding. This step will assess the fit that these application areas have with existing and potential federal funding sources and mechanisms.
2) Competitive landscape. Identify how Maryland is positioned compared with other leading research concentrations in the selected research platforms, based on publications and grant activities.
3) Assessment of market potential, including consideration of the timing of market opportunities; extensiveness of technology issues that need to be addressed and whether they are more basic or applied in nature; and potential for types of industry collaboration and whether they are more with major companies, start-ups, or a combination.
4) Assessment of economic linkages to the Maryland bioscience industry base, including the level of industry activity and Maryland's competitiveness in those sectors that are closely linked with the selected research platforms.

Resources Required:

It is recommended that $2 million a year be targeted to the development of federal lab/university/industry, with a matching fund requirement.

Performance Measures:

- Increase in academic R&D funding in the targeted technology area
- Number of spin-out companies developed around technology developed by centers
- Number and value of licenses generated
- New products introduced by companies participating in the collaborations

Lead Organization(s):

MBC and TEDCO

Action Fourteen: Support university and community college bioscience development projects

Rationale: The future of the biosciences in Maryland will depend on the continued excellence of the state's academic bioscience research complex. A key distinguishing feature of robust bioscience states is the presence of high-quality, available research labs and specialized core facilities. Those research universities with

sufficient space and facilities are likely to attract a disproportionate share of federal funds since they have faculty workspace , which is at a premium at many universities throughout the country.

Looking to the future, it is critical that Maryland's public colleges and universities have continuing access to state capital funds for ensuring that they have the laboratories and equipment to enable their researchers to compete successfully for bioscience R&D dollars and to continue to produce talented bioscience graduates.

Proposed Activity: The LSAB strongly supports the state's capital budget process and uninterrupted investment in planned bioscience research facilities at Maryland's public colleges and universities. The following facilities are among those being considered for capital investment in the near term:

- Chemistry Building Renovation at UMCP
- Smith Hall Addition/Renovations at Towson University
- Natural Science Lab/Crawford Science Building Expansion at Bowie State University
- Health Sciences Facility III at UMB.

In addition, Maryland's community colleges have documented needs in excess of $134 million for FY 2009 in high-priority capital projects, with much of these facilities needed to support course offerings in the biosciences. Future needs include expansion and renovation of chemistry, biotechnology, and life science labs at Cecil College; renovation of a science building at Harford Community College; new Bioscience Education Centers at Howard Community College and Montgomery College (Germantown); and a new Microbiology Lab at Prince Georges Community College.

Resources Required:

This LSAB recommendation does not involve spending beyond that already planned, but is intended to underscore the LSAB's view that following through with planned capital investments in the state's life science research and education infrastructure is critically important to the continued growth and success of Maryland's bioscience industry.

Performance Measures:

- Increase in research funding associated with new capital investments
- Retention and recruitment of federally funded faculty within new funded facilities or users of core laboratory facilities
- Enhanced industry-campus interactions (incubator performance, workforce training, collaborative partnerships and sponsored activities)

Lead Organization(s):

The Maryland Board of Regents, USM, Maryland Higher Education Commission, and Maryland Community Colleges

Strategic Priority Four: Advance bioscience talent generation and workforce development

Action Fifteen: Advance a systematic and coordinated statewide approach to developing bioscience career pathways

Rationale: Workforce development is a critical requirement of the bioscience industry in Maryland and elsewhere. Higher education is of course critically important; however, the largest share of employment opportunities in the biosciences nationally is found in production and technician positions, typically requiring associate's and bachelor's degrees. Production occupations comprise more than 50 percent of the occupations in the medical device industry, more than 40 percent of the occupations in the pharmaceutical industry, and more than 30 percent in agricultural chemicals. While Maryland enjoys a high concentration in top-end bioscience research workers, industry has significant concern about the insufficient supply of production and technician-level workers.

The bioscience industry in Maryland benefits from a number of excellent individual program efforts in bioscience education and career development. However, the Governor's Workforce Investment Board (GWIB) has identified a number of challenges confronting Maryland in bioscience workforce development, including the following key challenges:

- Lack of a statewide approach to gaining industry involvement to guide bioscience workforce development across secondary and postsecondary institutions.
- A need for improved program articulation in the biosciences between community college and 4-year degree programs. Maryland has one of the nation's finest community college programs; yet, the many associate degree programs offered in Maryland in biotechnology, biosciences, and associated information sciences are not always easily transferable to more advanced degrees. One potential model is emerging at the Germantown campus of Montgomery College. Through a partnership with Montgomery College, the UMCP will offer a baccalaureate degree in biotechnology, with full articulation to the Associate in Arts (A.A.) degree in biotechnology offered by Montgomery College. A separate partnership between Montgomery College and the Montgomery public schools provides for middle school teacher education, bioscience summer camps, and high school biotechnology academies.
- Lack of a statewide program to introduce high school students to bioscience career opportunities. A potential model for improvement may be found in an initiative of Project Lead The Way (PLTW), a widely heralded career-technical education program, which has developed a new biomedical sciences program and is advancing it in 10 Maryland high schools using federal funds gained as a result of Maryland's strong performance in the Workforce Investment effort.
- Uneven funding of higher education making it difficult to build and maintain programs in bioscience education.
- Unmet demand for scientists with industrial experience.

Proposed Activities: The LSAB recommends that Maryland advance from the current dependence on individual and sometimes fragmented approaches to bioscience education toward a more coordinated and systematic statewide approach to developing bioscience career pathways. Specifically, the LSAB recommends the following steps to advance career pathways and bioscience workforce development in Maryland:

- **Support implementation of the new PLTW Biomedical Sciences High School Program across high schools in Maryland**. A critical component of Maryland's long-term strategy to develop its future bioscience workforce is career and technical education focused on applying education related to science, technology, engineering, and math (STEM) to introduce high school students to bioscience career

opportunities through a curriculum that teaches problem-solving, critical thinking, and team-building. PLTW stands out in its ability to engage students who may not be top performers, in classes that include high-performing students. PLTW also does well in attracting girls and minorities to technology-focused career learning. The historic PLTW focus has primarily been engineering. Recently, PLTW has developed a Biomedical Sciences Program with eight state sponsors, including the State of Maryland. As one of the top two sponsors, Maryland was given the opportunity to select a university in the state to serve as the PLTW Biomedical Sciences affiliate. Stevenson University serves in this role as one of only two affiliates in the nation training high school teachers to deliver the Biomedical Sciences curriculum.

Maryland has had a very successful experience with PLTW's Engineering Program. Nearly 100 Maryland high schools now offer some portion of this engineering program, and 33 high schools offer a fully certified PLTW Engineering Program. As noted previously, Maryland is advancing the new PLTW Biomedical Sciences Program in 10 high schools, using federal funds awarded to the state for strong performance in the Workforce Investment Program.

The LSAB recommends that the state ramp up efforts to bring the PLTW Biomedical Sciences Program on line in high schools throughout the state. The goal would be to add 20 new high schools each year for the next 5 years to bring the total to at least 100 high schools with all school districts in the state represented. The cost per year is estimated to be $1.6 million based on $80,000 per school to bring the program on line for 4 years. With Stevenson University as a training site for the PLTW Biomedical Sciences Program, the Maryland teachers will be training in-state, thereby optimizing the investment in Maryland's program.

- **Promote program articulation for biotechnology, bioscience, and associated life science degrees across high schools, community colleges, and 4-year degree colleges.** The recent GWIB bioscience workforce study identifies six community colleges offering biotechnology or bioscience degree programs at the associate level, with two other community colleges in the planning phases; but, there is no statewide policy to ensure program articulation.

  Over the years, Maryland has made significant progress in articulation from community colleges to 4-year degree schools. Today, general education credits earned at the community college level articulate fully to meet the requirements of 4-year degrees. However, true program articulation presents a more significant challenge. New ground has been broken recently in the area of teaching degrees, with A.A. degrees in teaching fully articulating into 4-year teaching degree majors. Presently, work is underway to do the same in engineering. For the life sciences, an excellent example is the Bachelor of Science (B.S.) degree in the Biological Sciences Program offered for the past 8 years at the USM Shady Grove campus in Montgomery County by the College of Chemical and Life Sciences of the UMCP. This program articulates with programs at several community colleges, including Montgomery College.

  It is critical that all biotechnology, bioscience, and associated information-science associate degrees offered at Maryland's community colleges articulate to 4-year degree majors. Industry involvement in this process is critical.

  The LSAB recommends that a one-time study be conducted by the MBC in cooperation with the Maryland Higher Education Commission (MHEC) at a cost of $250,000 to assess how best to advance program articulation in biotechnology programs across associate to bachelor degree programs, with linkage to the new PLTW Biomedical Sciences Program.

Resources Required:

Costs are proposed as follows: $1.6 million annually for implementation of PLTW over the next 5 years; $1.4 million annually to support the Talent Bridge Program; and $250,000 (one-time funding) to support the development and implementation of an articulation plan.

Performance Measures:

- Number of students in biotechnology-related programs at high school, community college, and university level (Associate of Science [A.S.], Associate in Applied Sciences [A.A.S.], B.S., Master of Science [MS], Doctor of Philosophy [Ph.D.])
- Graduates from biotechnology-related programs
- Placement of graduates seeking full-time employment in the biosciences in jobs in Maryland

Lead Organization(s):

MBC, Maryland State Department of Education (for PLTW), and MHEC and Maryland Community Colleges (for articulation approaches)

Action Sixteen: Create the Maryland Bioscience Workforce Skill Development Fund

Rationale: Nationally, the highest share of employment opportunities in the biosciences is found in production and technician positions, typically requiring associate's and bachelor's degrees. Nationally, production occupations comprise more than 50 percent of occupations found in medical devices, more than 40 percent in the pharmaceutical industry, and more than 30 percent in agricultural chemicals. Even in hospitals, the largest percentage of occupations is found in nursing and health care support occupations.

There is also a strong requirement on bioscience workers to be life-long learners and able to pick up new skill sets. Critical skill shortages can emerge quickly in the biosciences and pose major impediments to industry growth in particular niche areas.

While Maryland enjoys a high concentration in top-end bioscience research workers, bioscience companies are significantly concerned that production and technician-level workers are not in sufficient supply. Maryland also lacks a statewide approach to gaining industry participation in guiding bioscience workforce development across secondary and postsecondary institutions.

Proposed Activities: Maryland needs a statewide bioscience workforce effort that has the resources to work alongside education and training providers to help create the programs, curriculum, instructional labs, and teacher professional development that respond to the specific needs of the bioscience industry. Typically, education and training providers are able to maintain programs, but have a difficult time finding the resources to update or create new programs.

It is proposed that grants of up to $100,000 be available for updating and creating the curriculum and teacher professional development components for new bioscience programs at the postsecondary or workforce training levels. Bioscience education or workforce development programs qualifying for these grants would need to have identified employers seeking workers with the skills to be developed to serve as a program steering committee.

Additional funding should be available to support the instructional lab equipment needs of approved bioscience career development programs offered by postsecondary education or training providers. These grants should be available to existing programs with a proven track record of training and placing graduates in bioscience jobs or to new programs with successfully developed curriculum and teacher professional development components.

The MBC should retain the right to make use of the curriculum and teacher professional development components of individual programs with other postsecondary and training providers in Maryland to spur their use in different parts of the state.

Over time, the Fund should consider ways to host the curriculum and teacher professional development of vetted, proven programs in an on-line environment with lesson plans, student e-portfolios, and teaching tips as well as providing support for teacher networking and mentoring by master teachers in specific program areas.

Resources Required:

The Bioscience Workforce Development Program Fund would be funded at $1 million per year for all activities including need identification, curriculum development, professional training, instructional equipment grants, on-line hosting, and teacher mentoring.

Performance Measures:

- Graduates from biotechnology-related programs
- Placement of graduates seeking full-time employment in the biosciences in jobs in Maryland
- Filling key skill shortage areas for Maryland bioscience industry

Lead Organization(s):

MBC and work in concert with specific post-secondary institutions

Action Seventeen: Develop and retain bioscience scientific and entrepreneurial talent

Rationale: Bioscience CEOs report that it is still difficult to find experienced bioscience scientific and management talent, a common experience in most states and regions seeking to grow their bioscience industry base. Maryland has a variety of programs to assist emerging bioscience companies in raising the funding needed to recruit management talent, such as the Challenge Investment Program and the Enterprise Investment Fund. A concerted effort is also needed to grow scientific and management talent able to work effectively in Maryland's bioscience industry.

Proposed Activities: It is proposed that Maryland support the development of bioscience entrepreneurial and executive talent as follows:

- Develop a bioscience talent bridge program to help provide a transitional pathway from academia to industry
- Encourage programs that provide entrepreneurial education to bioscience students and entrepreneurs.

The **Maryland Bioscience Talent Bridge** Program would provide fellowships to enable bioscience companies to employ postdoctoral students and recent Ph.D.'s. Maryland graduates a significant number of people with bioscience graduate degrees and attracts many of the nation's top postgraduate degree professionals to work at NIH, FDA, and its university and medical centers; but, there is no clear pathway to transition from academia to industry. Mid-level scientific positions typically require both

New Jersey Technology Fellowship Program

The New Jersey Commission on Science and Technology offers a New Jersey Technology Fellowship Program through which the Commission pays stipends to recent Ph.D.'s (within 6 months on either side of receiving a degree) who agree to be placed for a 2-year postdoctoral fellowship with a New Jersey technology company (all fields) that has selected the student for the program. The fellowship pays $65,000 in the first year and $75,000 in the second, with an additional $10,000 toward an expense budget. The company must have New Jersey as its principal place of business, 75% of its employees in-state, total revenue less than $10 million, and a minimum of three employees or consultants each employed at least 25 hours a week. The fellow must be in good standing with the conferring university. However, the program will not fund foreign students, and the supply of citizens or permanent residents with Ph.D.'s in appropriate fields has apparently not kept pace with the available funding or industrial demand, despite the subsidy.

postdoctoral training and industry experience; yet, few companies provide transitional opportunities, thus this highly educated group tends to fall between the cracks, viewed as overqualified for technician positions and not yet qualified for researcher positions.

The Maryland Bioscience Talent Bridge Program, to be administered by the MBC would help postdocs and recent Ph.D. graduates gain the initial industry experience necessary for them to receive consideration as candidate employees by Maryland's small bioscience companies. Such a program would also benefit the companies by providing them with a recruiting pathway through which they could provide training without incurring undue costs to bring potential permanent employees up to speed. Interest in such fellowships would likely be high, as evidenced by a recent symposium and career fair sponsored by Rockville Economic Development, Inc., TEDCO, NIST, and others, which attracted over 500 postdocs. The MBC would also offer networking events, workshops, and experiential learning opportunities.

Explore development of entrepreneurial education for bioscience graduate students and postdocs. Maryland has a number of entrepreneurial development programs, some considered national models. The University of Maryland's Dingman Center of Entrepreneurship is recognized worldwide as a leader in enterprise creation, and the Alex Brown Center for Entrepreneurship at UMBC was designated a Kauffman Campus in 2007. Maryland's ACTiVATE Program (Achieving the Commercialization of Technology in Ventures through Applied Training for Entrepreneurs) has helped women entrepreneurs commercialize technologies from UMBC, UMB, UMBI, UMCP, JHU, NASA, National Cancer Institute, and NIST. The LSAB recommends that the MBC explore ways to make entrepreneurial education programs and resources more readily available and targeted to bioscience graduate students and postdocs by offering lecture series, project-based short courses, and peer mentoring.

Limbach Entrepreneurial Center

In 2000, local entrepreneur Scott Limbach had an idea to establish a new kind of resource for entrepreneurially minded academic scientists working in the University of Pittsburgh Cancer Institute that would go beyond patenting and licensing to educate and assist in the commercialization of new ideas to improve human health. Over the following 2 years, the Limbach Entrepreneurial Center grew to become an integral part of UPCI, growing new companies and spawning new collaborations with industry partners. The key to the success of the Limbach Entrepreneurial Center was its new model for a different kind of technology transfer—one that was centered around the inventor, not the invention, and that focused on developing a unique plan for each discovery aimed at moving it from the benchtop to the patient. In January, 2004, armed with innovative concepts such as a peer-role model lecture series, extensive entrepreneurial education, and the development of a highly skilled and deeply experienced staff, the center expanded to serve the more than 2,300 health science faculty across the University of Pittsburgh's six schools of health sciences.

Resources Required:

The LSAB recommends that the Maryland Bioscience Talent Bridge Program target grants of 20 fellowships per year, to ensure an impact over time. The cost per fellow is estimated to average $70,000 per year, with an annual total cost amounting to $1.4 million. The MBC should engage in the development of entrepreneurial education efforts, seeking private sponsors for key activities such as networking, lecture series, and peer mentoring.

Performance Measures:

- Number of talent fellowship recipients that remain employed in Maryland 2 years after completion of fellowship
- Number of bioscience graduate students and postdocs entering bioscience industry

Lead Organization(s):

MBC and work in collaboration with federal laboratories and universities